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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled:

Visual Communication Design Fundamentals

Specific to NAPLPS Videotex

submitted by Karen Hodgson

in partial fulfillment of the requirements for the degree of Master of Visual Arts.

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M. V. A. FINAL VISUAL PRESENTATION

by

Karen L. Hodgson

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Abstract

Videotex is a unique and growing computerized system for the delivery and presentation of graphic and textual information. This system is designed for, and being used by the general public. The potential for information dissemination through this medium is therefore great. There is clearly a role for the visual communication designer to play in the delivery of this information.

Unfortunately, because this technology is new, guidelines for effective information display on videotex have not yet been defined. Observation of videotex databases reveals that pages are crude, cluttered, garish, difficult to read, chaotic in their organization, and lacking in unity. Informational messages to be transmitted to the viewer are confused and difficult to decipher. There generally seems to be an inability to communicate visually, in an effective manner, with this medium.

Clearly, page creators urgently need guidelines for the effective, efficient manipulation of videotex text and graphics. This project attempts to define fundamental principles of visual communication design, specific to NAPLPS videotex. These guidelines are based on research on how people respond to visual stimuli from a colour computerized display of information and on graphic design experience. Research is drawn from computing (human factors), psychology (visual perception), visual communication design for print and other related disciplines.

The project attempts to provide a strong conceptual framework for these human factors considerations and therewith, a structural outline for further research. Medium unique design considerations are addressed. Print design principles are not considered directly applicable.

This project is divided into two parts; a software instruction programme entitled "Graphic design for videotex", designed for page creators with little or no training in graphic design or human factors research, and this written research report. Guidelines are presented in a basic, concise form in the software, in accordance with the space limitations imposed by the medium, while more detailed recommendations and justification are provided in the report.

The documentation and the course are divided into six main sections; Planning, Text, Colour, Form, Design principles, and Synthesis. These sections are preceded by an introduction outlining the project background and objectives. A conclusion and bibliography follow.

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Background
Videotex is a complete colour, computer graphics system created for the presentation of textual and pictorial information. It differs from other computer information systems in that it is designed to communicate to the general public. This focus on serving the public has enormous implications in terms of information dissemination and hence the role of visual communication design. Videotex is also unique in that in addition to text, it generates colour graphics, at a relatively low cost. Most computer information systems are alphanumeric, that is, they present text information only.

The videotex system may be divided into two aspects for the sake of description:

1. The information provider
2. The user

The information provider encompasses the necessary hardware, software and human resources to create, deliver and maintain the computer information "pages" to be viewed by the user. Concept and/or content are developed by a client in cooperation with a videotex specialist. The material is then input into a videotex "page creation station" and converted to pictures and text by the "page creator". Completed pages are normally stored in a database where they can be accessed by users.

Typical components required to produce, store and transmit pages are a computer, videotex software, a videotex decoder and some form of telecommunications link. Although many early page creation and storage systems were designed for videotex functions only, it is now possible to perform these functions on a variety of multifunction micro, mini and main frame computer systems.

The videotex decoder is a crucial component of this system. It decodes the ASCII (American standard computer code for text) Picture Description Instructions (PDI's), translating them into the videotex standard text and graphics which appear on the television or computer monitor.

It is also worth noting at this point, that videotex page creation software is particularly "user-friendly". It is designed to be operated by individuals with no computer experience, and requires no programming.

On the user side, an individual can access these stored information pages with a few simple components; a television and/or microcomputer, a decoder and a telephone modem. Decoders may be hardware or software and may even be implemented in the television or monitor. The user connects to a videotex database via the modem and the data is transmitted over the phone line, through the decoder where it is translated to videotex images, which are displayed on the television or computer monitor. Page access is controlled by the viewer via a keypad or keyboard. Commands are usually extremely simple. Database search is also designed for "naive", noncomputer users. Pages can also be broadcast over television signals to home viewers.

Videotex is the "generic" term for the system described. In Britain and parts of Europe, the term viewdata is used. Teletext is the term used to refer to broadcast videotex. Videotex is two way interactive (the user interacts with pages in a database as desired), whereas teletext is limited to one way interaction (images are broadcast in a predetermined, limited sequence). In other words, a videotex user can search large sections of an information database in many directions, and carry out a dialogue with the system, while a teletext user can only select from the pages being broadcast at that time.

The Canadian government videotex system is known as Telidon. It was developed in the late seventies as an alternative to its predecessors, Prestel in Britain, and Antiope in France. These early systems developed in the seventies in response to increasing demands for electronically generated information.

Prestel as well as a number of other European videotex systems, produces text in a similar manner to North American systems. However, British and European graphics are often limited to rather crude images made up of predefined, low resolution squares. Pictures generated on

these systems resemble a mosaic. Hence, they are referred to as "alpha-mosaic" systems. North American systems on the other hand, are primarily "alpha-geometric". This means that the elements used to make up images and text on the screen are actually geometric forms or primitives. These primitives are the point, line, rectangle, polygon, and circle or arc. All videotex pictures are then constructed from these basic geometric elements.

Alpha-geometric videotex images are normally generated at a resolution of 256 x 200 pixels. Alpha-geometric systems are however capable of generating higher resolution pictures with more sophisticated hardware. "The Picture Description Instructions... provide a means of coding graphic images for storage, transmission and interpretation such that the coding is virtually independent of the terminal configuration and communications channel."(Bown et al. 1979, p.14) Costs to users for high resolution hardware are however, prohibitive at present.

Great effort has been expended in recent years into establishing standards for videotex systems. A standard for this technology means that all hardware and software falling under the presentation protocol retains the same minimum features. This is significant in terms of large scale communications compatibility especially since videotex is ASCII based. Most existing large scale public and business computerized information services are in ASCII. Marriage of ASCII and videotex information services will be significant in terms of the quality and quantity of information available through such services.

In 1980, the CCITT (International Telegraph and Telephone Consultative Committee, Geneva) established an international videotex technical standard encompassing the alpha-geometric (Telidon), serial alpha-mosaic (Prestel), and parallel alpha-mosaic (Antiope) codes for text graphics and colour. Subsequently in 1983, the ANSI (American National Standards Institute), and the CSA (Canadian Standards Association) simultaneously issued the NAPLPS (North American Presentation Level Protocol Syntax). This standard, is based on the Telidon alpha-geometric system and was established by AT&T (American Telephone and Telegraph). Most videotex hardware and software now being produced in North America conforms to the NAPLPS standard. A detailed explanation of the NAPLPS code is available in the CSA-T500 publication.

The NAPLPS standard provides page creators with an elaborate set of options for designing pages. To be labeled as NAPLPS, systems must provide SRM (Service Reference Model) minimum functions. Manufacturers are free however to expand, at greater expense, the NAPLPS features available with their decoders and software. A typical system may offer the following options to the page creator:

- construction of geometric primitives (points, lines, polygons etc.)
- editing of primitives or groups of primitives including; move, copy, reorder, rotate, erase, substitute etc.
- anywhere from approximately 500 colours to millions of colours
- a wide range of text sizes
- text editing capabilities
- DRCS (Dynamically Redefinable Character Sets), enabling the page creator to design and invoke new character sets
- alternate text fonts
- proportional character spacing
- mini-database construction
- slide show structuring and so on.

Other aspects of the page creation system include the potential for limited animation, control of image display order, and viewer interaction (e.g., key word selection). Note that recent advancements integrate sound, video, photodigitization and other technologies with videotex. This document does not address these developmental aspects. Establishing recommendations for using these options would require a much lengthier investigation.

Videotex was initially designed for home access with a conventional television set. Although this is still the largest market for the service, videotex is also becoming increasingly available to home, business, library and educational microcomputer users. This is significant with

respect to viewing habits and will be addressed.

Typical services available to videotex users include such things as:

- shopping
- banking
- stock market reports and analysis
- statistical information
- news, weather and sports
- agricultural information
- government information
- employment opportunities
- community information
- games
- advertising
- instruction/courses
- business information
- recipes
- messaging
- driving tests
- accomodation guides
- information on everything from eyecare to films to energy conservation

The *limitations* of NAPLPS videotex will be discussed shortly.

Videotex and the Visual Communication Designer

It is clear that *the potential for information dissemination through videotex is enormous.* Recent activity indicates the possibility for large scale growth of this industry. Several factors contribute to this likelihood:

1. Videotex technology has been adapted to microcomputers. The significance of this marriage is openly acknowledged (Badertscher, 1984; Greenhouse, 1984). Although people are unwilling to outlay money for videotex technology itself, they are willing to buy a micro package that provides videotex capabilities (Allen, 1984,). It also means that businesses, libraries and educational institutions can lock into this technology with their microcomputers. Considering the incredible growth rate of the microcomputer industry at present (Feeley, 1982; Greenhouse,1984), videotex may well proliferate at the same pace.

2. Videotex is ASCII based. New developments allow users to access both ASCII alphanumeric and videotex graphic data with the same system. ASCII text can be fed into a videotex system for formatting into NAPLPS pages. Integration of these two standards can provide an enormous wealth of information for a variety of user groups, and can apply bright color graphics to ASCII alphanumerics.

3. Videotex provides services of interest to naive computer users. Complex data search skills or computing knowledge are not required. Users can easily access simple services like banking, shopping, community news, courses etc., which are of more interest to the public than conventional database material (Beacher, 1984).

4. Videotex offers colourful, flexible graphics at low cost, compared to other computer graphics systems. The colour graphics offer a distinct advantage over monochrome text presentation in terms of creating interest and improving information comprehension.

5. Integration with other technologies such as video, sound, telecommunications, photography, television etc., should hasten the adoption of videotex in the current technology revolution.

6. As observed at Videotex '84, major companies such as IBM, Digital, Sears, Sony, AT&T, CBS, Wang, and so on are taking a very active interest in videotex, and are in fact producing software, hardware and/or databases conforming to the NAPLPS standard.

Any system which has such a great capacity for information delivery is of particular importance to the visual communication designer. Designers should play a key role in the creation of videotex pages as the demand for videotex content intensifies. The designer's expertise in the analysis, organization and presentation of information should serve to improve the quality and comprehension of service provided to users. The importance of the designer's involvement in human factors aspects of computer graphics is only now beginning to be recognized (Marcus, "Graphic design for computer graphics", 1983; McLaren, 1984; Mills, "Evaluating the impact of videotex images", 1982).

As Foster and Champness (1982) point out, "poor design can be expensive to both the information provider and the information consumer.... The way in which information is presented in itself communicates an impression of the status and credibility, the image, of the information source. By using displays that the reader finds attractive and can readily comprehend, the designer adds an intangible message to the explicit information on the page." (p.255). The importance of the visual communication designer's involvement becomes increasingly apparent as one examines the weaknesses in videotex technology and content.

The problem

The title of a recent draft for an article by Ian McLaren (1984) aptly describes the current state of videotex computer graphics: "Videotex- if this is the shape of things to come, why does it look so nasty?" (This title was later shortened to "Why does British videotex look so nasty?") Although this new medium would appear to offer much in terms of graphic potential, observation of videotex databases quickly reveals that this technology's visual capabilities have by no means been exercised. Writers on videotex have been openly critical of videotex pages. (Stone, 1983; Reynolds, "Typographical and design considerations with viewdata", 1979). Pages are visually garish, cluttered, difficult to read, poorly organized, and lacking in unity. They generally fail to deliver a clear message with impact. There appears to be a distinct inability on the part of page creators to communicate effectively (visually). This is ironic considering that the medium was designed for facilitating the communication of information.

There are several factors responsible for the poor visual quality of videotex content:

1. Generally, there are distinct problems associated with viewing electronic displays. Research has shown that VDT (Visual Display Terminal) viewers complain about eyestrain, blurred images, headaches and general fatigue during prolonged working sessions at such terminals (Murch, "Visual fatigue and operator performance...", 1983; Dainoff et al., 1981; Matula, 1981; Treurniet). Many factors work together to make viewing computer graphic pages more difficult than viewing the printed page. These factors will be discussed as we proceed. The fact is, regardless of what is contained in a videotex page, users are going to experience discomfort when viewing pages.

2. Videotex technology has certain technical limitations which are problematic. Although videotex graphics are superior to many of the microcomputer graphics, in that they offer more colours and more flexibility, they are still of very low resolution. The creation of good graphic images using a resolution of 256 x 200 pixels, requires a great deal of time and hard work. Text provided by the system is extremely crude in comparison to print type. It is limited in its size, structure and spacing. The smallest size is very large, which results in pages crammed full of text in an effort to transmit enough information. The videotex electronically generated colours produce substantially different results from printed colours. Colours are extremely bright and gaudy. It is also difficult to control luminance and contrast and to find appropriate and aesthetically pleasing combinations when using coloured light. Images are also displayed on the screen element by element in a tediously slow fashion. This means that pictures must be kept very simple in an effort to shorten presentation time.

3. Pages are being created by unskilled operators. As videotex is a relatively new technology, and a computerized one, most individuals involved with the system are engineers, computing specialists, systems analysts, marketing specialists or technical researchers. In addition, because the system is user-friendly, anyone and everyone likes to get on the keyboard and "draw pictures". Consequently, pages are being created by computing people, business personnel, clerks, teachers, and so on, all individuals with no design or artistic training or perceptual human factors background. On the other hand, graphic designers are terrified of computers. This misapplication of skills seems to pervade the computer graphics revolution. A visit to any of the on-going computer graphics conferences quickly reveals the engineer or computer scientist, "would-be-artist", and the

unprofessional results. Twyman (1982) points out that with technological advancement, the design of graphic language is passing from the specialist to the layperson. As computer technology becomes accessable to many, the layperson is increasingly assuming the role of the information designer. All this is not to say that videotex page creation should not be carried out by nondesigners, only that there is a definite need for guidelines to assist page creators in the presentation of information, in the interest of effective communication.

4. There is a distinct lack of research on videotex human factors, especially visual communication with videotex. Extensive research and funding has been committed to the development of hardware, software, communication links, teleconferencing, microsytem adaptation and other technical endeavours. Oddly, there has been little research on human response to the visual stimuli presented on a videotex terminal. In an effort to launch the new technology, emphasis was concentrated on these technical developments with little concern for content. It is only now with accelerated growth of the industry, and the increasing demand for content, that information providers are becoming concerned with the quality, effectiveness and efficiency of pages, with respect to information delivery. Psychological, sociological, human factors and visual communication research into videotex is just beginning to surface. Some of this research will be mentioned. Unfortunately, much of the research that does exist was conducted with pre-NAPLPS videotex and viewdata, with their limited colour choice and alpha-mosaic graphics. As an alternative, computing human factors, and psychological research can be borrowed from to a certain extent.

5. Designing with videotex is not like designing for print (Reynolds et al., 1978; Foley, 1979; Foster and Champness, 1982). It is not possible to directly apply the principles for designing with print to videotex. Page creators have tended to adhere to print conventions with less than successful results. They have in fact rendered the videotex terminal a "page-turning device", where text is pumped in and fills the screen like a book. Page creators seem to have some difficulty in knowing what works visually with this medium, and usually end up using print principles, guessing, or depending on the technology's default solutions.

6. An important economic factor restricts page creators. Production of pages is costly in four respects:

1. Page creation time
2. Storage space
3. Transmission costs
4. Display time

In an effort to keep pages short in byte length, certain concessions, on the part of the information provider, are inevitable.

Clearly, some basic skills are lacking when it comes to the presentation of information on videotex. Quality standards which were established long ago for other mediums such as print, have yet to be developed for this technology. The problem is then, that *page creators urgently need guidelines for the manipulation of videotex text and graphics* (visual not technical manipulation). These guidelines must take into consideration human factors (psychological, perceptual, sociological, subjective and physiological reactions), visual communication design theory and practise, and economic factors. As well, they must focus on the effective, functional communication of information, not just on aesthetics or artistic experimentation. These guidelines must be understood by "naive" page creators regardless of whether they are engineers, secretaries or statisticians.

Objectives

The main objective of this project is to solve the above stated visual problem: that is, to recommend basic guidelines for the effective, efficient presentation of graphic and textual information, in NAPLPS videotex pages, and to provide them in a form, useable by page creators.

Several secondary objectives also exist; to identify differences between designing for

videotex and designing for other mediums such as print (medium unique principles), to create a strong conceptual framework for further research, to explore the limitations and capabilities for visual communication with this particular medium, and to provide a base of graphic design fundamentals that can also apply to other computer graphics systems. These secondary objectives will be investigated throughout the project but will not necessarily be dealt with at great length, as they are not of primary concern.

Design process
Based on the above objectives, four design process phases evolved:

1. The initial step towards fulfilling the described objectives was a research phase. Although very little research has been done specifically on videotex human factors, a great deal of pertinent literature from computing, psychology, sociology, education, visual communication design and related disciplines may be borrowed from. Relevant research was first collected in order to provide important information about how people respond to colour computer graphic displays in general, and to videotex displays specifically.

2. Based on this research, and on visual communication design experience, recommended guidelines for the manipulation of videotex text and graphics were developed.

3. The third phase was the actual creation of a videotex software instruction programme to teach page creators these guidelines. Printed guidelines for an electronic medium are insufficient for illustrating medium unique fundamentals. Consequently, it was decided that instruction in the same medium would not only be the most effective method of delivery, but would also insure that the guidelines were directly accessible to page creation system users, and therefore of some practical use in terms of improving videotex page quality.

The software was therefore designed for a specific user group, the naive page creator: naive in that they have little or no understanding of or training in, design, and specifically in graphic design for videotex. As hardware and software vary, the course also assumes that the page creator knows how to operate their individual page creation system. The point of the course was not to teach operators how to technically produce videotex pictures and text, but rather how to create effective, efficient visuals. A more detailed description of the software instruction programme will be presented shortly.

As the instruction programme developed, it quicky became apparent that it was essential that the course creation be divided into three stages:

A) Stage A was Content Development. This involved the creation of pages containing the major points or guidelines to be passed to creators, with illustrations to reinforce the content.

B) Stage B would be the addition of interactive testing. In order for learning to take place with programmed instruction, it is advisable to test learners on the information provided (Skinner, 1954). Therefore, testing pages must accompany the content to keep student's attention and interest, and to provide reinforcement. This stage would require advice and assistance from educational specialists. Testing would likely be organized in a branching programmed learning structure, so as to be compatible with existing tree structured database software.

C) Stage C would be evaluation. This is important to determining the effectiveness of the instruction programme.

It also became quickly apparent that the completion of these three stages (A,B,C), would require an enormous amount of work and thorough investigation far beyond the scope of this project. It was therefore decided that the present project would encompass stage A of phase 3 *only*, that is, the Content Development.

4. The final phase of the project was the documentation of the project and the recommended guidelines, accompanied by the

appropriate research justification. The document which you are now reading represents this phase.

The present project therefore encompasses; phase one, two, stage A of phase 3 and phase four. Viewable products include, the course content and the project documentation.

Equipment
The courseware for this project was produced on a Norpak IPS-2 videotex page creation station with RGB output, and a Mark IV decoder upgrade to the NAPLPS standard. A large Sony monitor was sometimes utilized. Createx-C NAPLPS page creation software, a programme produced by TV Ontario, was used to create the pages. To enable pages to be viewed on a microcomputer for the purpose of demonstration, pages were downloaded to an Apple IIe micro utilizing Alphatel Systems Limited page creation and database software. The same software was used to organize the course pages into a computer "slide show" for viewing and storage. Master copies of the pages exist on eight inch floppy disks viewable on the Norpak system. Duplicate copies exist on small floppy disks viewable on an Apple microcomputer with a videotex decoder and videotex software. As well, 35mm transparencies of selected pages were shot.

The guidelines
It is important to note that the guidelines provided in this project are indeed recommendations only. The author certainly does not claim that these are *the* absolute answers to designing videotex pages. Rather, the guidelines are more a framework for basing further research on. Some topics are well researched, while other areas lack sufficient study with respect to VDT viewing. Much of what is proposed, is based on a combination of empirical evidence, experience, knowledge of perceptual processess, an understanding of visual communication design, and much theororizing. In a work of this breadth, one can only expect to establish initial guidelines. Each of the areas covered will require many years of further research. It is hoped, that this will provide a strong conceptual framework and impetus for further investigation.

Research cited must be accepted cautiously. One must question the value of single element, scientific testing as applied to graphic design or art. Although the results of scientific testing are certainly useful as guides, it should be remembered that not only are laboratory conditions rarely duplicated in real life, but that individual screen arrangements are also rarely alike. The complexity and individual dynamics of any one page of information can drastically alter the effect of one single element on the viewer. Colour, text, form and arrangement of elements interact with aspects which may have been tested in isolation. With respect to the operation of the visual system Kasvand (1981) states: "Furthermore, one experiment gives only some data about a very limited aspect of the whole system. The excitation of a part of a system may not necessarily produce the same effects as when this part is operating in unison with the rest of the system, nor is there any way to isolate a function or a mechanism and measure it independently of its imbedding." (p.91). For the most part however, these studies may be borrowed from with a grain of common sense.

Note that the guidelines cited basically follow the structure of the software instruction programme. The software is entitled "Graphic Design for Videotex".

Audience
As described, the guidelines and the course were designed to assist adult page creators with little or no knowledge of or training in graphic design. These page creation system operators may have a little or a lot of experience in page creation, and will know how to operate their own particular page creation station. This group was selected as a target because, as mentioned, most page creators are not professionals in the field but rather have been called upon from other disciplines to fulfill the needs of a new discipline still void of expertise. Typically, these people depend on their equipment and guesswork when designing pages without controlling or defining specific messages or objectives. The course is designed so that the operator becomes more aware of the visual messages, intended or otherwise, that the viewer receives. The page creator is considered as a

communicator rather than an artist or an input person.

Although some large commercial videotex operations now employ professional graphic designers, even these people do not seem to be aware of the implications of related research and experience with videotex. The course and documented guidelines may therefore be of use to more experienced information providers as well. Such a course may be advantageous, in that it could save training person hours and improve the quality of output for information providers. The course may also be of use as a training device for students of graphic design who are learning about computer graphics and/or videotex at educational institutions.

Course material and language is presented at a level suitable to the above described group. Points are basic and concise, with illustrative examples provided, within the limits of the course length. More detailed explanations for given guidelines are presented in the documentation.

Technical parameters
Certain technical restraints had to be considered when preparing both the guidelines and the course. Although the project focuses on NAPLPS videotex, it should be kept in mind, that there are variations in interpretation of the standard. Systems may also range anywhere from the most basic minimal SRM NAPLPS with few colours and features, to elaborate, multiple option, upgraded systems supporting far more capabilities. Not all NAPLPS features are supported by all decoders. For example, if pages are created on a system offering colour modes one and two, and then displayed on a system offering colour mode zero only, the elaborate range of colour palettes available with one and two, will convert to the single sixteen colour palette available with colour mode zero. Simpler systems which do not support features beyond SRM will only display to their particular capacity. For this reason, the entire course was created in colour mode zero. This would insure that what was created on the screen would reproduce on other systems as closely as possible to the original. This consideration is crucial if the page creator does not know what type of decoder will be used to display pages. On the other hand, if the display device is known, options can be employed to fit. The guidelines themselves are broad enough principles that they should be applicable to the majority of NAPLPS systems.

Another technical restraint is the type of monitor/T.V. output signal. Although pages may be created on a station with RGB output, it is highly possible that viewers may receive pages through RF (Radio Frequency) or composite video signals, particularly if pages are displayed on a home television set. This means that viewers may receive a very "fuzzy" image interrupted by horizontal scan lines. In addition, the display device may have a screen of unknown size, may offer little or no control over contrast, brightness and colour, or may in fact be a monochrome set. Colour subtleties and fine detail which may be very effective on the page creation system, could be rendered indistinguishable in the viewing environment. It is advisable to preview pages on a monitor or T.V. similar to that which would be used by the recipient, and to avoid subtlety of colour contrast. The possible poor quality of picture output was kept in mind as the guidelines developed.

Perhap the most important technical parameter associated with videotex page creation is the afore mentioned cost factor. Every page produced affects creation person hours, storage space, transmission costs, and display or viewing time. It is essential that page byte length be kept as short as possible. The more detailed the page, the longer it takes to create, the more space it takes to store it in, the more expensive it is to transmit, and the longer it takes for the recipient to view it, which in turn is expensive to the user in connection time, and annoying to watch. Viewers find long display times particularly aggravating (Elton and Carey, 1983; Toombes, 1983; Tombaugh et al., 1982). Page byte length was therefore a major controlling factor in determining the guidelines.

Other technical considerations include, environmental factors such as glare, reflection, room light, viewing distance, monitor size, monitor location etc. Some of these factors will

be discussed at greater length in the guidelines.

Emphasis
The project undertakes some specific foci. Computer graphics and indeed videotex must be divided into two factions:

1. Screen viewing
2. Print reproduction

Information can be designed to be viewed in its finished form directly from a colour VDT, or it can be prepared, using the computer as a tool, to be reproduced in print form. The course and guidelines are designed for screen viewing *only* (which is very different from transferring the material to print). Videotex can be used to produce 35mm transparencies for print, but it is primarily a VDT medium. Factors such as the nature of electronic colour or display time and order, would not pertain to print applications.

The course and guidelines are directed primarily at information design as opposed to advertising design. This decision was based on the notion that the ethics and functional motivation (commercial gain), of advertising, differ from those of information design. Doblin (1980) sums up this distinction by saying:

> Information must be true; if it is not it is misinformation. Persuasion does not have to be true; it uses that part of the truth needed to convince. Whereas information opens minds so that they can function rationally, persuasion is calculated to close minds to all other messages except those favourable to the sender.(p.97).

Design decisions are modelled on a strict goal of visual communication of information in an efficient, rational manner as opposed to manipulative persuasion. Advertising may be considered as a separate topic with its own unique guidelines. Once again, proper coverage of this area is beyond the scope of this project. However, many fundamentals established for information design can be applied to advertising.

The project focuses on human factors, that is on viewer response: doing everything possible to make pages easy to read, view and understand. Although aesthetics must be considered to a certain extent, the functional operative principles which control where the viewer looks and what they will perceive from a visual image are of primary concern.

Finally, as detailed in the previous section, the project emphasizes reduction of the cost factor. So, in a few words, the guidelines emphasize efficient, effective, functional delivery of information.

Structure
The documentation and the course are divided into six sections; Planning, Text, Colour, Form, Design principles, and Synthesis. It was decided that the basic tools (text, colour, form and design principles) should be introduced to page creators before discussing how to combine the tools (synthesis). It will suffice to say that knowledge of form and materials (and their related meaning), and the ensuing manipulation of them using basic design principles, are fundamental to art and design pedagogics (Hodgson, 1983). Planning of course, precedes this process. A summary and references follow the main content. The documentation offers additional information on future topics, and research requirements.

Terminology note
Note that hereafter, the individual who works at the page creation station, designing videotex pages, will be referred to as the *operator* or the *page creator*. The organization which creates and provides videotex pages will be referred to as the *information provider*. The people who will view the pages produced by the page creator, will be referred to as the *viewers, users* or the *audience*. The person or organization requesting pages from the information provider will be referred to as the *client* or the *originator*.

Introduction
Planning is one of the most critical parts of designing videotex pages. Yet, judging by the cluttered, disorganized appearance and structure of videotex pages, it is perhaps one of the most neglected areas. The absence of planning is particularly evident in page groups which require a consistent organizational system and some method of "visual linking". More often than not, an organizational overview is ignored in favour of "churning" out pages one by one as they are required, solving individual problems as they surface.

As the page creator is responsible for the effective delivery of information to the viewer, it is essential that he or she prepare a creative plan or process to facilitate the cogent transfer of specific messages to viewers. "Many studies of the creative act recognize that it usually, or often involves the steps of problem definition, analysis, generation, synthesis, development, refinement and presentation."(Bedno, 1972, p.355). Cartier (Godfrey and Chang, 1981), recommends a preparatory process to be carried out prior to actual input of videotex pages:

1)Design:
Audience analysis.
Defining objectives.
Information gathering.
Content analysis and classification.
Processing raw data.
Content development.
Structuring: Tree diagram.
Overall visual design.
Choice of characters- colours.
Documentary consultation.
Tests.
Development of layouts.(p.132).

Cartier's list outlines typical concerns for the information provider when planning pages. It defines an analytical, problem solving process for this medium, and is a useful reference.

Audience identification
Audience identification and analysis is very important to the creation of videotex pages (Godfrey and Chang, 1981; Johnson, 1982; Williamson, 1981). It is vital that visual and verbal messages be tailored to individual requirements, in order to retain interest and facilitate comprehension on the part of the user. This can only be accomplished after the viewer's identity has been clearly established. Research indicates that videotex markets are not only very different, but are very specific, that is, different markets for different subjects or usages (Reymer, 1982). One can not assume that pages will be viewed by a "general" audience. Each user group has unique needs, behaviour, knowledge levels and interests. If users are paying for videotex services and information, it stands to reason that the information they select must be of specific interest to them. Their identity should be clarified.

Questions to be posed when identifying the audience include: What is their viewing environment? What are their cultural experiences? What is their age group? What is their knowledge level? How much time will they have to view pages? How far from the monitor will they be? Are they a group, or an individual (Johnson, 1982)? What will attract them? What will hold attention? How can we help them to learn and remember? Are they easily distracted (Marcus, "Graphic design for computer graphics", 1983) What assistance will they need? What will they expect (Williamson, 1981)?

Users may be business professionals, homemakers, farmers, consumers, statisticians, students or shoppers. An in-depth look at the users' demographic characteristics, physical constraints, expectations, motivation and subjective responses will reveal special needs which must be met. A simple example is presented in the course. If pages are being produced for an executive presentation, the audience may be plus or minus fifteen feet from the screen. If pages are viewed in a library or on a school microcomputer, the user may only be a few feet away. Text sizes and detail level should be selected accordingly. A business audience will expect serious, direct, professional images and organization, while children will need something to attract and hold their attention and interest. Text, pictures, colours, organization, timing and sequencing chosen, should relate to the specific audience.

In addition to pinpointing characteristics of a specific target audience, it is useful to be aware of concerns relating to human beings and their responses to stimuli from a colour computer display in general. Physiological, psychological, perceptual reactions, visual problems, memory retention, attention factors, and aesthetic norms and values should be considered. These issues will be dealt with as the documentation proceeds. It should also be kept in mind, that generally page creators should minimize the effort to view and understand pages and should maximize the efficiency of information transfer. "Ease of understanding can be judged by the clarity of the message."(Glenn, 1984, p.16)

An important issue worth noting at this point, is the facilitation of the transition from print presentation to electronic presentation. One teletext trial (Elton and Carey, 1983), showed that "those encountering teletext for the first time often borrow habits and expectations from their experiences with other media.... Initially it may be better to build upon these existing habits and patterns rather than try to convert consumers to an elaborate and unfamiliar information service." In other words, people's expectations for print organization and visuals may be carried over into the videotex medium. Complex tree structures and unexpected machine responses may have a negative effect on a public with little experience with computer technology. Easing them into the new medium can encourage acceptance and understanding. Bolton (1982, p.173), in his discussion on "Diffusion Theory" in relation to videotex also emphasizes that compatibility with "current consumer experiences, values and needs..." will play an important role in whether people adopt videotex or not.

People's habits for processing information are deeply ingrained. Certain print conventions must be retained. It will be some time before people are sufficiently familiar with the new medium to accept radical changes in structure and presentation. Glenn (1984), sums up this concern for people's conventionalism: "The basic thing to keep in mind when communicating 'information' is that it is directed at people. We can help alleviate real concerns that many persons have about the limitations of the 'new information society' by giving *meaning* to information- essentially by striving to complement electronic presentation with the ways that people, not machines, perceive and understand the world around them." (p.22). Information providers should keep the users' perceptions and habits in mind as they plan. Some preconceived print conventions must be acknowledged.

Topic familiarization

Once the target audience has been identified and analyzed, it is the page creator's responsibility to familiarize him/her self with the information to be delivered to the viewer. Operators can not expect users to know what is being communicated visually, if they themselves are not clear on the message to be delivered. Page creators should read the copy provided by the originator, ask questions and if necessary do some outside research on the subject. This will help them to determine appropriate imagery, impressions, themes and emphasis that must be transmitted. Dialogue with the originator will assist in this research. Familiarity should aid the communication process.

Defining objectives

If the information provider understands both the audience and the topic to be delivered to that target group, he or she is then in a position to identify the visual problems to be solved and in turn to define objectives. Page creators should pinpoint specific goals. Questions to be asked when determining these goals include: What is the purpose of these pages? Do we wish to inform, educate, entertain, sell...? What is the message? What kind of impact is desired? What mood or theme should be set? How will the audience affect the pages? Should a corporate identity to be evident? Are pages part of a larger series?

Once these questions have been answered, objectives can easily be defined. The page creator must then do everything possible to fulfil those objectives. All components of a page should work together towards these goals. Text, colour, form, organization and timing must be suitable. Consider for example, pages to teach safety measures to equipment operators. Objectives might be: Pages should

teach operators to... (list topics), users should be able to... (list) on completion. Clarity is essential. Information must be easy to understand. In order to prevent injury, there must be absolutely no errors or ambiguity, visually or verbally. Text must be clear and direct. Language and presenation should be suitable to equipment operator's educational level. Images must emphasize critical points and show sufficient detail. Colours must be functional and not distracting. Information must be neatly ordered in a rational, sequential, fashion. Emphatic devices such as timing and animation should be utilized if they help to explain. Any decorative or nonessential information should be eliminated, and so on.

Similar logic can be applied to many types of pages. Objectives will determine the form that pages take. The objectives can then also become criteria for confirming appropriateness and functionalism of elements. Page creators should define objectives and periodically check to make certain they are being fulfilled.

Practical restraints
Certain pragmatic concerns must be examined in the planning stage. Budget, time and workload are valid confines. It is up to the information provider to determine how many pages can be produced in a given time and consequently how elaborate or heavily illustrated they may be. Although pictures take longer to create, they can often say more, and can guarantee attention and interest. It should be kept in mind, that pictures also reinforce messages and can aid retention. (This subject will be dealt with further in the section on "Form".) Likely the most practical solution is to alot time according to the importance of the job. More time should be spent on essential services or high level audiences such as executives who would be using pages to base decisions on.

Pages should also be flexible enough that they can incorporate changes and updates as time dictates. This includes leaving page series open to the addition of new pages (Williamson, 1981).

The final primary practical restraint to be observed is the four cost factors discussed earlier. Efficiency is imperative. Byte length should be kept to a minimum.

Storyboarding
Storyboards, such as are used for film and television, are useful devices for organizing and planning videotex pages. They can lend visible structure to an otherwise entangled hierarchy of information. On an individual level, each storyboard offers a place to identify the topic, the page number, the file number, the page layout (images, text and ther arrangement), and a description of the page message. The storyboard also serves as a reminder that each page is an individual unit, separate from other pages, and as such must be capable of standing on its own and of still being meaningful.

On a multiple unit level, storyboards can be used to construct a videotex database in tangible form. Unless operators are experienced with computer storage of information, they may find it difficult to envision the digital placement of data on a disk or tape. This rather abstract concept can be better understood if material is structured in a recognizable, visible sequence, that has some relationship to print ordering. Storyboards can be pinned on the wall in the desired order and then be numbered according to the database numbering system. This will also enable page creators to overview the page series and test the flow; reordering, omitting, inserting and making adjustments as needed. This overview also "insures visual unity through the consistent application of a system of visual priorities... questions of style, colour, form content, position, byte count and display time are solved at the storyboard stage." (Johnson, 1982, p.298)

Simple storyboards can be drawn four at a time, on an 8 1/2" x 11" sheet of paper, copied and cut out for use, or proper forms can be preprinted. These storyboards also provide a convenient print record and framework for discussion and approvals with the originator.

Text preparation
Writing for videotex is very different from writing for a book or a magazine. Screen space restrictions dictate that text used must be very concise, especially if accompanied by

illustrations. As McFarland (1982, p.306) states, "Videotex is a short word, short sentence, short paragraph medium." It is often necessary to use abbreviations and to eliminate articles like "the" or "a". Point form lists are also useful. Writing for videotex must be brief, rather like writing for a T.V. or radio spot or a brochure. It is not advisable therefore, to directly input text written for print into videotex. Text should be written specifically for the medium. Copywriters and originators should be made aware of space restrictions and be given a character count for pages *before* text is written. Once again, active dialogue with the originator will facilitate the planning process.

As information is being prepared, it should be logically grouped and organized into succint units. It is very important that each page represents one idea or point (McFarland, 1982; Hum, 1982). Lane (1980), refers to videotex as a "modular" medium. Information is stored and presented in component parts. When users view a page, they can not see the information before or after it. As the page disappears, concentration is broken (Reynolds, "Teletext and viewdata- a new challenge for the designer", 1979). Text should not be run from one page to the next and especially should not be broken in mid sentence or mid paragraph. Pages should stand alone as idea units. Originators should also be made aware of this.

Finally, before text is written, the page creator should establish a format and grid to define text areas. This will enable them to prepare a character count for the copywriter.

Layout planning
Planning also involves overviewing the visual format of pages. This takes place on two levels:

1. Single pages
2. Page series

Consistency and unity in pages can promote comprehension because viewers will know what to expect and where to look. They will also know what information is related. In an effort to organize and unify information within and across pages, some sort of visual organizational system should be struck. The grid provides the necessary formula for ordering and visually connecting material. A grid system should be prepared before pages are designed and produced.

In addition, a colour scheme as well as colour and spatial codes should be determined before creating pages. These will contribute to unity and consistency. As part of this formatting procedure, space should be alloted for running heads. Simcox (1983), points out that, "Studies in spatial cognition have shown that people can become very lost without the use of landmarks or reference points to orient their perception.... Providing descriptive headings for each data group or reply presentation is one of the simplest ways to orient the user of videotex." (p.225).

Client/originator image
A further planning consideration is how the originator wants viewers to see them- what image they should project. Businesses, educational institutions, and other organizations usually have some sort of visual identity which is retained throughout their printed material, products and working environments. This identity may include a trademark, specific colour schemes, consistent typography and a general image or feeling that they like to impart about their organization. That identity should be established so it can be an integral part of pages, contributing to the professional appearance of the organization. A natural food and health group for instance, may have a special logo, a preference for organic images, natural, earth colours and "down to earth" dialogue with viewers. A computer business may want the latest "high-tech" contemporary approach to information presentation. One organization may want a "fun" approach, another a very serious approach. Page creators should find out as much as possible about the nature of the originator's organization and define text, colours and images which are appropriate. They should also determine if a logo is to be used. Note that complex logos *should not* be used on every page as they take far too long to display. If the company must be identified, a simple text identifier or small symbol is acceptable. A corporate logo could be

used on a single title page to introduce the page series.

Approvals
Finally, approvals should be procured at the planning stage. When sketches for each page have been prepared, and the order for storyboards has been determined, the originator should be consulted. Changes, additions and deletions should be made at this point. Time and cost estimates can also be established. Getting approval in writing could save hours of work later. It can also insure that charges can be safely made for author changes *after* approvals have been given.

Summary
Planning is extremely important. Page creators should begin the planning process by identifying the user audience. People who will be viewing the pages should be carefully analyzed. The following factors should be considered:

- age
- viewing environment
- distance form screen
- cultural experience/attitudes
- knowledge level
- time to view
- group or individual?
- interests
- expectations
- distraction/attention level
- motivation
- perceptual reactions
- visual problems
- memory retention
- values

Pages should be planned to minimize the effort on the part of users to visually process and understand the information that is presented. Some user print conventions must be respected. Page creators should also familiarize themselves with the material to be delivered to the user; asking questions and if necessary doing some outside research on the topic. Dialogue with the originator is essential.

Page creators should define problems to be solved by them (purpose, themes, messages etc.). Objectives should then be clearly identified. Objectives should then be used as criteria for checking the effectiveness of pages. At this stage, practical restraints such as time and budget should be considered.

Storyboards should be used to plan and organize pages. Pages should then be overviewed for unity and consistency.

Text should be specially written for videotex. Text must be very concise. Character counts should be prepared and given to the copywriter. Copy should not be run from one page to the next. Individual pages should, where possible, contain only one idea. Formats should be defined before pages are designed, so text area is known.

Page layouts should be designed for consistency and unity both in single pages and across page series. A grid, colour scheme, and text and image positions should be predetermined, especially for pages that must be visually linked or related. Page designs, should be previewed on the display device.

The originator's visual identity should be acknowledged. Complex logos should not however, appear on every page. The originator's approval should be sought at the planning stage.

Generally, page creators should consider effectiveness and efficiency as their main concerns in the preparation process. Page byte length should constantly be kept in mind.

Medium unique aspects of planning
Although basic design problem solving processess used in other mediums, can be applied to preparing pages for videotex, there exist some differences unique to the videotex planning process. As there are tremendous problems associated with VDT viewing, page creators must make special effort to keep pages clear and easy to read- much more so than in print. As viewing conditions do vary so greatly, it also becomes important to preview pages on the device used by viewers.

Pages must be planned both as isolated units and as unit series. As other pages are invisible,

pages must be capable of working or standing alone. In addition, page creators must control flow, sequence, routing, command and numbering structure, and timing. Database construction and search is a new concept of information organization for individuals accustomed to dealing with print. Making certain that people do not get lost becomes a necessary page creation skill.

Unique technical restrictions control the page creator (resolution, text size and crudeness, electronic colour, and so on). It becomes necessary to plan how to *exploit* the unique technological features to advantage, rather than wishing they were different.

Page capacity is severely limited especially for text. All page components have to be concise and minimal. Copy preparation is therefore unique. Running heads become important orienting devices. The page creator also has to assume certain editorial responsibilities (McLaren, 1984).

The restrictive cost factors are unique. Page creation time, storage space, transmission costs and viewing time and cost, must be respected when pages are planned.

Videotex audiences are generally naive computer users. No new conventions for dealing with computerized information exist for them. It becomes important to plan for questions and mistakes in the interactive dialogue between users and the information. Setting up this interaction is also a unique problem for the creator. Page creators must also facilitate the transition from print to electronic information processing.

Layout development with videotex is different. Creators can try out colours, formats and images on the screen and see immediate results of the finished product without waiting for proofs or printing. When actually designing pages, creators must also keep the structure of pages and page series flexible enough to accept frequent updating (which the technology readily permits).

Text

Introduction

Reading from electronic display screens, is more difficult and causes more eyestrain than reading from paper. Many factors contribute to problems of legibility and readability of VDTs; reflection and glare, ambient light levels, display luminance and contrast, viewing distance, flicker, screen curvature, monitor limitations (such as phosphor deterioration, resolution, poor font design), eye problems and so on.

Viewing and reading letters made up of light puts more stress on the visual system. There are no distinct edges between letters and the screen background (Grandjean, 1980). Light "bleeds" from the dot pixel, creating a fuzzy image. This forces our visual system to continually work at trying to refocus the image, putting great strain on muscles controlling this activity (Dainoff et al., 1981). Schmidtke (1980), also points out that: "Visual acuity [resolving power for detail] of many operators even when corrected is less than normal and the condition of room illumination and its installation are in many cases not optimal." (p.268).

Many studies have been conducted which confirm the problems associated with reading from electronic displays. Dainoff et al. (1981) for example, studied 121 office workers performing tasks at VDT stations. Testing yielded a high incidence of eye fatigue symptoms, indicating that VDT viewing strain is clearly a matter of concern. The author cites several studies showing similar results. Murch ("Visual fatigue and operator performance...", 1983), in a study measuring accommodation, convergence, visual acuity and refocus latency, found that visual acuity, was significantly reduced when subjects worked on a raster display. A 15% increase in myopia was noted and compared with similar results (22% increase in myopia), from an experiment by Haider et al. Murch goes on to identify screen glare, eye discomfort, health complaints and character legibility as the main complaints reported in display viewing surveys.

With respect to videotex specifically, Muter et al. (1982), found that test subjects read videotex 28.5% slower than a book during a two hour session. Text in this experiment was generated on a television set with RGB output. Had the test been conducted on a television with RF or composite video output, the difference could have been even more significant. Treurniet (1981), points out that, "When extensive reading is to be done from the television display, it is being used for a purpose for which it was not expressly designed." (p.1). Obviously this compounds reading problems with videotex.

So, when providing reading material for users, text legibility and readability are of great importance. Although much research has been generated on this subject in relation to print (Tinker, 1963; Spencer, 1968; Foster, 1980), print research is not necessarily applicable to videotex. As there is little research on videotex text readability and legibility, it becomes necessary to examine related VDT research. General print principles for manipulating text may also give insight into what will work best with videotex with its unique typographical features.

Generally, text information must be presented in a fashion that is easy to see, decipher and understand. Viewers should not have to work at reading pages. Information should be communicated efficiently. With this in mind, certain general organizational principles can be borrowed from print; such as the use of "chunking", hierarchical structuring, and spatial segmentation in relation to the content. Research has shown that the use of these structuring and organizational devices, can significantly improve comprehension and recall on the part of the reader (Hartley, 1978; Glenn, 1984; Green and Payne, 1982).

Reynolds et al. (1978), provide an extensive survey of research on the legibility and readability of viewdata displays. Much of this survey is applicable to videotex. Readers are advised to consult this survey for a comprehensive look at typographical considerations for this medium.

Examination of videotex text characteristics lends insight into the problems associated with reading videotex specifically. Character fonts

are extremely crude and unusually large. Although the videotex protocol permits resolution much finer than 256 x 200 pixels, almost all videotex material is presented at this resolution. When characters are generated in the standard six by ten matrix, resulting letter shapes are very limited. In addition, the smallest standard size is about the size of a twenty four to thirty six point print letter (depending on the monitor size). This large character size only permits about forty letters in total to span the screen from left to right, with about twenty lines of text vertically. This text size is enormous for the space given. The text was of course, originally designed for reading at a normal television viewing distance. So, operators are very limited in terms of text space and in terms of using space to divide and structure information (much more so than in the print medium).

Beyond the "smallest" size available, operators may select from a range of sizes, which translate the original matrix into larger "block pixels" resulting in letters with gaps and ragged edges. These "staircased" letters are even more crude than the base character. Sometimes operators have the option of defining their own matrix within the same 256 x 200 resolution.

Decoders and software also vary in their interpretation of NAPLPS characters. One system may translate the same matrix into an entirely different letter from another system. Some systems have specially designed fonts in addition to the "standard" NAPLPS range. Some decoders permit the option of using proportional spacing, some do not.

Word spacing is also very "gappy". Continuous text contains holes and distracting "rivers" of space running vertically through the text.

All of these factors present the page creator with special problems for selecting, organizing and spacing text. Special care must be exercised in order to present text in a clear and readable fashion.

In addition, operators have little understanding of typographical design. Page text is normally very poorly organized.

Upper and lower case

The question of whether upper case (capitals), or a combination of upper and lower case, is better for reading from videotex is an issue of some controversy. Print research on case, clearly shows that lower case (with capitals on sentence and proper word beginnings), is read more efficiently than all upper case lettering in continuous reading situations (Tinker, 1963; Spencer, 1968; Reynolds et al., 1978). Some tests have shown, that for long distance viewing, word search tasks (Reynolds et al., 1978; Foster and Bruce, "Reading upper and lower case on viewdata", 1982), and label reading (Morse, 1979), upper case lettering is more acceptable. The use of lower case text for continuous text reading, is however, the accepted rule.

The evidence for reading from videotex is not nearly so clear cut. In an oral reading test of forty subjects at a distance of 1.5 meters, Foster and Bruce ("Reading upper and lower case on viewdata", 1982), found that there was no significant difference between reading upper or lower case on viewdata. It should be noted however, that this was an oral reading task, which may have, as the authors point out, obscured any real differences between reading the cases. Similar (not significant) results were found in a videotex oral reading test of twenty subjects, conducted by Foster and Champness (1982). However, the text read in this test was completely meaningless. The test thus can not be compared to normal reading situations where meaningful phrases and context may be important. Sutherland (1980) claims that tests indicate that readers prefer upper case lettering in subjective testing. One wonders if this is a question of familiarity, as most early videotex was produced in capitals. The medium is certainly young enough that users could be conditioned to accept lower case lettering as a norm. Lower case lettering is also used mostly for continuous print text, a convention that for new videotex users is accepted. Subjective responses may also have little to do with reading speed and comprehension of text, although they certainly are valid in determining acceptance factors for viewers.

Treurniet's research (1981) on Telidon fonts,

also shows no difference between rate of reading upper or lower case. However, these tests were out of context, word identification tasks, which once again *do not* simulate a normal reading situation. Test groups were also quite small.

It is clear that more thorough research is required with regards to this issue. Tests which have been conducted are by no means conclusive. Study on upper versus lower case should include reading rate in normal reading situations and comprehension testing, not just letter or word identification or search tasks in meaningless copy. The reason for this will be explained shortly.

Other important factors to be considered in relation to upper versus lower case are, viewing distance and proportional spacing. Traditionally, normal home television viewing distance, which is about seven times the screen height (Treurniet, 1981; Reynolds et al., 1978), has played a major role in videotex layout and text decisions. Recently though, videotex applications have changed. Viewers can now access text from microcomputers, in libraries, businesses and schools. Readers may therefore be positioned much closer to the screen. Home television viewing distance can no longer be an absolute criteria for using the capital letters (assuming that upper case is preferable for long distance viewing). Also, the early tests on case were conducted largely on text *without* proportional spacing. In nonproportionally spaced text, upper case text spacing is much better, presumably because the spacing system was originally designed for upper case. In lower case nonproportionally spaced text, great gaps occur between letters and words. In print these types of gaps impede reading flow (Craig, 1980). It can be hypothesized then, that proportionally spaced lower case lettering would improve reading speed, therefore yielding a superior reading rate rather than a similar reading rate when compared to upper case text. In a medium where space is at a premium, substantial cost savings could be realized by using proportionally spaced, lower case lettering, because lower case letters take up less space than upper case letters. Proportional spacing is also becoming a fairly common implementation in videotex decoders.

Generally, videotex specialists recommend the use of lower case lettering (with upper case at sentence and proper name beginnings) for videotex text (Reynolds et al., 1978; McFarland, 1982; Reynolds, "Teletext and viewdata - a new challenge for the designer", 1979). Other computer display specialists also recommend the use of lower case lettering over upper case (Reading, 1978; Roufs and Bouma, 1980; Marcus, 1982; Davis and Swezey, 1983; Morse, 1979). The basis for accepting lower case over upper case, is the fact that, "we perceive text in units, whole words, sometimes a phrase, even a sentence." (Reading, 1978, p.22) It is not just individual letters which enable us to read text and grasp its meaning. Whole words and even familiar phrases are quickly recognized without examining each word letter by letter. This recognition is easier with lower case letters because, they have a more distinct visual shape than upper case letters. Ascenders and descenders give each word a unique shape. These shape variations may play a significant role in speeding recognition and reading rate (Haber and Haber, 1981; Well and Pollatsek, 1981; Reading, 1978; Tinker, 1963; Foley, 1979).

As there appears to be no detrimental affect from reading lower case on videotex, and print research so clearly favours lower case, lower case lettering is recommended for running text until further research is produced. Capitals are acceptable for short text areas, labels, titles, or long viewing distances.

Text sizes
Typical sizes available with videotex are small, medium, normal, double height, and double size. The selection of acceptable quality text sizes is extremely limited unless specially designed fonts are available. The two smallest sizes are really the only presentable sizes. Beyond that, text must be self-constructed, or DRC's must be used, or existing fonts must be manipulated. Ragged characters can be "cleaned up" by adding dots and lines.

In terms of choosing which size to use, quality, and viewing distance are the main determinants.

Page creators should select a size that can be read at the audience distance. As NAPLPS sizes are so large to begin with, it is rarely necessary to use sizes other than the two smallest ones. The larger sizes are simply too crude to use. If the page creator then opts to construct letters for larger text, an existing typeface should be used as a model. A skilled graphic designer can prepare good quality DRC's if they are to be used. Caution must be exercised when constructing words or setting up DRC's. They increase display time and page byte length severely, and should be used sparingly.

Size change is also normally used in other mediums to create emphasis and denote hierarchical order in text. However, emphasis and hierarchy can be established through the use of bolder text (the second text size), colour or by isolating the text with space. These three devices are very effective when used alone or in combination. It is not really necessary to add a fourth emphatic device (size change). It may in fact contribute to confusion. Using too many emphatic devices could effectively camouflage the highlighted information. The course material uses only one size, spatial separation and minimal colour change to define a text viewing hierarchy.

When using colour change to denote hierarchy, the brighter, high luminance colours should be utilized for making the most important information stand out. Colour change should be used sparingly though or the page will be too busy. One colour change per page only is recommended. Use of size change should be limited. Larger sizes should be self-constructed and used sparingly.

Note that on displays with higher resolution, smaller text sizes may be available. They should be used for close viewing only. When such sizes are available, assuming that larger sizes are of acceptable quality, use of size change may be appropriate.

Line length
The length of lines of text can affect speed of reading (Spencer, 1968; Morrison and Inhoff, 1981). Line length is inextricably linked to text size, text font, amount of text, line spacing (leading), viewing distance and letterspacing (Craig, 1978). When one variable is changed, the other variables may be affected. For example, text fonts with more vertical thrust will require more leading than other fonts. Suitable text line length must be selected specifically for the size and leading inherent to the videotex system.

Print research shows that optimal line length for text is about fifty to seventy characters or two and a half alphabets long (Spencer, 1968; Craig, 1980). Recommendations for suitable line lengths on CRT's are similar (Marcus, "Designing the face of an interface", 1982). Kolers et al. (1981) in a CRT reading test comparing character densities of thirty five and seventy characters per line, showed that reading speed was faster with the longer line length. Note that the short lines used very large text (suspiciously like videotex text, although this was not specified). The long length lines were displayed using a much smaller, condensed font. The authors concluded that: "Reading smaller, more densely packed characters requires less ocular (and presumably less cognitive) work."(p.525) This study is interesting in that it compares videotex-like text with more conventional CRT text. It suggests that reading videotex-like characters even with a maximum, full screen width line length (approximately thirty five characters), may be even more difficult than reading "normal" CRT text. It is also a reminder that it is not necessarily safe to extrapolate from CRT research when defining guidelines for videotex.

In view of the very thorough research available on line length selection for print, videotex specialists have recommended that the maximum line length be used for videotex (Reynolds, 1982; Sutherland, 1980). This length of approximately forty characters comes closest to the print guidelines for linelength. This is however, a dangerous presumption. Almost all text readability and legibility studies have been conducted with small (eighteen point or less), print in continuous reading situations at a normal print reading distance. With the exception perhaps of sign research, very little testing has been done on reading large text sizes.

As mentioned, the smallest videotex text size, depending on the monitor size, is about twenty four to thirty six points high. Even though television viewing distance of this size may simulate "normal" viewing conditions, this is not certain. Also, the viewing distance may be much closer, now that videotex is being used with microcomputers. People do not normally read long lines of large sized text. Text of this size normally only appears on posters or exhibits, where there is only a small amount of copy, and where viewers are not reading for a prolonged period. It is therefore suggested that these print guidelines are not applicable to videotex, as videotex reading conditions are in fact very unique. Research on videotex fonts specifically is needed to determine appropriate line length in relation to the system text size and leading.

Consider what happens when a videotex screen is filled with text. Stretching text fom one side of the screen to the other creates inordinate clutter. The reader experiences no sense of visual relief from the mass of characters. Filling the screen is inadvisable (Reynolds, "Typographical and design considerations with viewdata", 1979; Reading, 1978; Merrill, 1982; Jackson, 1979). Therefore, some space must be alloted for blanks and images. If text is run the full length of the screen, the insertion of blank or pictorial space will leave several very long lines of text with extreme horizontal thrust. The landscape format of the screen accentuates this. Blocks of type would be long and narrow. Regardless of whether the screeen is full of text or not, especially at close range, the standard leading is insufficient for the character size and long line length. The lines appear to be crammed too close together, especially if there are only a few lines of text. This crammed appearance slows reading because, "lines above and below the one read will interfere with parafoveal word recognition [recognition in peripheral vision] unless line distances are sufficiently large."(Bouma, 1980, p.109). Treurniet's studies on videotex text (1981) showed that letter scanning rate increased as leading was increased, and that readers preferred larger leading. It appears that substantial compromises have been made in defining the default linespacing for NAPLPS text presentation, in order to gain more screen lines of text.

Contrary to popular opinion, the author proposes that a shorter line length for videotex running text in the smallest size, should be adopted. Alternately, since the existing default leading is insufficient, for the text size and forty character line length, leading *could be* increased. Spencer (1968) points out that: "Leading permits line length to be extended without loss of legibility." (p.55). This would however, shorten the available working space. Assuming also that some space has been left for images and blanks the long horizontal format would significantly reduce the options for positioning page pictures. Pictures would have to be very narrow and in a landscape format.

Since videotex text is so different from print and since the leading is insufficient, a line length of about twenty to thirty characters is recommended. This format would, permit greater flexibility in terms of organizing text, space and pictures, and would presumably be a more appropriate length for the default leading. Shorter line lengths require less leading (Craig, 1978). Experience indicates that it is a very comfortable length to read. Of course this line length should be tested.

When larger text sizes are used, the full screen width should be utilized. Otherwise, it would only be possible to get two or three words per line and excessive hyphenation would be a problem. Excessive hyphenation should be avoided. If large text is presented in this manner, space should be used to break up the text (Reynolds et al., 1978), and to reduce the horizontal thrust of the page. This can be accomplished by using a full line space between points or paragraphs.

It is also very important that line lengths are not too short. For running text very short line lengths of twenty characters or less, will create excessive hyphenation and presumably slow reading dramatically. Very short line lengths cause the visual system to make too many fixation pauses as the viewer moves to new lines, which results in a slower reading rate (Spencer, 1968). Short line lengths are

acceptable only if a small amount of text appears, as in captions, titles or labels.

Note that if smaller text sizes are available, more conventional guidelines (as for print) should apply. Otherwise, text lines should be about twenty to thirty characters long. These shorter text lengths can be implemented through the construction of a grid, which will provide a format for both text and images.

Text arrangement
Options for arranging text include; flush left, flush right, centered, justified or random. Print research favours alignment along a left edge for optimum legibility (Spencer, 1968). There are a number of reasons for this preference, which relate to the way we read, be it from VDT's or print. Justified text, that is text which is aligned against both a left and a right margin, has been forced to meet the margins by adding space between words and sometimes between characters. This leaves gaps in the text which, as in print can interrupt the reading flow. Gregory and Poulton's print reading research (1970), indicates that in short lines (four to nine words), justified text clearly presents problems in reading efficiency, especially for poor readers. In lines of twelve words or longer, the disadvantages of justification seem to disappear. The shorter line length testing may be compared to the typical videotex line, which if justified would contain large gaps between words. Therefore, if the option of justified formatting is available, page creators should not use it. In addition to decreasing reading efficiency, justified text would use more space per line.

Text which is centered between margins, means that each line is positioned in a different spot in a given space. This also means that when reading, viewers must search for a new starting point for every line (Craig, 1978). Consequently the user has to work harder at reading the page.

The same principle applies to text which is randomly positioned or flush right (although aligned at right,the left margin is ragged). Centered, random or flush right text is therefore not recommended for running text.

Flush left text on the other hand, is aligned against an even left margin and is ragged on the right. Readers always know where each new line begins. As Bouma (1980) states, "The horizontal extent of line saccades [scanning movements of the eye] is controlled by visual information in the left visual field, concerning the far left hand text margin, which therefore should be in a straight vertical line..." (p.103). Roufs and Bouma (1980) corroborate this by saying that this left vertical alignment, "enables eccentric vision to plan the size of the leftward jump reasonably accurately.... Requirements for the right hand margin are not as severe as for the leftward side..." (p.260) Note that Roufs and Bouma's report relates to reading form CRT's.

There is no immediately apparent reason why flush left formatting should not apply to videotex. Not only will readers know where to retrieve succesive lines, but the text will be neatly aligned and appear organized. As western readers read left to right, top to bottom, it is a logical system of text positioning. It is also the easiest to input on videotex. Running text should therefore be flush left, rag right.

Note that a convex rag on the right hand side is more pleasing than a concave one. Care should be taken that the rag is somewhat regular- without holes or words that conspicuously stand out alone.

Titles or headings on pages, for the same reasons as discussed above, should be positioned flush left. Videotex page creators tend to centre titles for no apparent reason other than it may be common typewriter practise. This is unacceptable practise.

Where possible diagram and chart labels should also be positioned flush left. Again, this contributes to a sense of neatness and organization on pages which normally have a tendency to easily become cluttered and busy.

Optical alignment
As a result of the differences in letter shapes and the varying positions of the letters in the character matrix, words positioned against a left

edge may appear to be misaligned. The left margin may appear irregular. For example, an "l" will not line up with a capital "D" on the line above, because the "l" is positioned in the middle of the matrix while the "D" aligns against the left edge of the matrix. In an effort to maintain the above described straight line at left, to control return saccades, adjustments should be made so that words are "optically aligned" against the left edge as opposed to mechanically aligned. Operators should select new starting points for words which disrupt the vertical alignment, so that visually the vertical appears constant. This is a particularly noticeable problem with text with nonproportional spacing and with larger text sizes.

Although making these adjustments in running text would be impractical, these adjustments are recommended for titles or captions where, because of their isolation from other screen elements, the misalignment becomes very apparent.

Proportional spacing
Videotex text with nonproportional spacing has frequent gaps within words. This disrupts reading flow within sentences and creates vertical rivers of space in the text block which also distract the eye. This "gappy" text also seems to be aesthetically less pleasing than proportionally spaced text. The extra space also reduces the number of characters that can be input per line. The use of proportional spacing is therefore recommended (Treurniet, 1981; Glenn, 1984). Further testing on reading proportionally and nonproportionally spaced text, and the relationship to text line length (that is text with the twenty to thirty character line length) with videotex, is required.

Wordspacing
Similarly, videotex text has large spaces between words which also create gaps in the text, which disrupt reading flow and detach words from one another. Certain character combinations are worse than others. These word spaces appear larger when letter spacing is reduced with proportional spacing. It is assumed that the word spacing for videotex was designed for non- proportional letter spacing and alters minimally when proportional spacing is implemented.

As with optical alignment, adjustments to gaps between words can be made by selecting new starting points closer to the previous word to reconnect related word strings. Again this is impractical for running text, but useful for titles or captions where words should be semantically connected. These gaps are also exaggerated when only a few lines of text appear. It is recommended that adjustments to word spacing be made where gaps are evident and where meaning can be improved by reconnecting words.

Character counts
In a medium where space is very restricted, it is important to determine screen capacity for text, before any writing is done. A character count will provide writers or originators with a guide to the amount of copy permitted per page, and will impress on them the need for laconicism. A character count can be prepared only when a format for the pages and text has been defined. Once space has been alloted for headings, commands, text, blank space, column divisions, margins etc., page creators should proceed as follows: The text area should be filled to capacity (on a test page), with copy. Then the average number of characters per line should be determined. That figure should then be multiplied by the maximum number of lines in the text area. So, if page creators multiply the number of characters per line times the number of lines per page, they should have a figure representing the total number of characters per screen for a specific text format. Counting characters is much more accurate than counting words because words vary in length.

This calculation will provide copy writers with a text maximum before illustrations are added. Space for pictures must be deducted from the total as pages are being developed.

Dark text versus light text
The ability to distinguish symbols from their background is dependant on brightness contrast rather than on colour change. Sufficient contrast between letters and their background must be retained for legibility (Bouma, 1980;

Timmers et al., 1980; Weale, 1978).

Note that contrasts can be degraded by bright ambient room light (Reynolds et al., 1978). Variation in TV and monitor display of colour can also diminish contrasts. It is therefore important that brightness, or light/dark contrast between text and background, be strong. Colour change is not sufficient.

In order to retain sufficient contrast, two options for text display exist; either light text on a dark background, or dark text on a light background. The question of which option is more suitable for videotex is another issue of controversy, which requires further study.

On the one hand, print conventions strongly favour the traditional dark text on a light background. Readers are accustomed to this presentation. Print research also indicates that reading black on white print is as much as ten percent more efficient than reading white on black (Spencer, 1968). When reading from CRT's, many viewers strongly prefer dark on light text presentation (Winkler and Konz, 1980). Under certain conditions, dark text on a light background is in fact read more efficiently when viewing a CRT (Radl, 1980; Bauer and Cavonius, 1980; Roufs and Bouma, 1980).

Both Radl and Bauer and Cavonius present interesting studies which show the effectiveness of switching from light on dark text to dark on light text on CRT screens. Better reading efficiency with the dark on light condition, in both tests, is explained by the fact that light backgrounds improve adaptation conditions for the eye (better acuity and contrast sensitivity), and glare and reflections are avoided. It would seem then, that for CRT viewing, dark text on a light background is better.

On the other hand, light backgrounds make "flicker" more noticeable. Flicker is a "jittering" condition of the screen, created by the refreshing of the VDU phosphor with light at a fixed rate. This refreshing can be detected by the eye even though we may not be conscious of it. Flicker is very noticeable if it falls below the critical flicker fusion (CFF) rate of about 50Hz to 60Hz. Flicker detectability also escalates in parafoveal vision and can vary with phosphor persistence (Reynolds et al., 1978). Most CRT's have a refresh rate of about 60Hz. North American television refreshes at 60Hz and European television at 50Hz.

Flicker is one of the most disturbing aspects of viewing VDT's (Bauer and Cavonius, 1980) and is the main cause of headaches and eyestrain for VDT users (Davis and Swezey, 1983). Flicker perceptibility increases with luminance (Roufs and Bouma, 1980; Bauer and Cavonius, 1980). Therefore when a light background is employed, flicker is even more noticeable and more irritating than usual.

In the afore mentioned Radl experiment, showing improved results with dark on light text, it is important to point out that the refresh rate used, was 66 cycles per second. In the Bauer and Cavonius test, the refresh rate had to be increased to 100Hz to eliminate flicker before the experiment could be carried out. Roufs and Bouma (1980), recommend that image frequency be higher than 70Hz.

Although adapatation conditions for the eye are better with light backgrounds, flicker is too severe a problem to ignore. As most televisions and videotex CRT's will be refreshed at 50Hz to 60Hz, flicker will be very apparent if high luminance, light backgrounds are used. Only a short period of observation of these conditions is required, to confirm the presence of flicker.

Also, in television the screen refresh is presented in a "line interlace" of 30Hz for each set of scan lines, to give a total refresh of 60Hz. At close viewing range, small details or single lines can appear at 30Hz, creating exaggerated flicker and line crawl (Treurniet, 1981).

In addition, although dark on light is like print, people are becoming increasingly familiar with electronic presentation of text in the reverse mode, whether it be on the airline departures monitor at the airport, or their instant banking computer or the microfilm index at the public library.

It is also evident, through observation, that characters, when presented on a light background seem to break down. Their pixel construction is revealed as dark "holes" without the benefit of bleeding light to fuse the dots into linear elements.

Bright backgrounds may also contribute to the busy, garish appearance which so readily occurs in videotex pages. As lighter, brighter colours seem to be more conspicuous, because of intensity of light eminating from the screen, the background also becomes the prominent element on the page rather than the information contained in the background.

For these reasons, it is strongly recommended that until display technology improves, for reading, text should be presented in a light colour on a dark background. This is not to say that contrast reversal should never be used. In areas where text and viewing time is short, and material is only presented this way in one or two pages, reverse contrast (dark on light) is acceptable as long as luminance is not too strong. It could in fact be useful at times to indicate that a change in type of information is occuring, as in title or section pages within a page series.

Colour selection for text

It is difficult to make recommendations for specific colour combinations of text and background. SRM NAPLPS videotex provides at least five hundred colours to choose from (although a palette of sixteen colours only, is normally available at any one time). Many systems provide thousands or hundreds of thousands. Colours vary not only in hue, but also in saturation and luminance, so hue naming is of little value. One can then only generalize with respect to colour choice.

What little colour research has been conducted, was carried out with with viewdata and pre-NAPLPS systems, offering only the original six colours, black and white and a range of grays. The grays have been excluded from testing altogether. Tests have also been conducted with character identification or subjective appearance evaluation as opposed to reading (Bruce and Foster, 1982; Champness and Alberdi, 1981). Most colour research, especially for videotex, also focuses on hue only. This is perplexing, as the nature of colour is so dependant on luminance and saturation. Test results which do not consider these variables are of little value. Further study is greatly needed in this area.

As discussed, contrast between the character and its background is more important than hue change. Luminance levels for text (assuming that the background is dark) must therefore be kept fairly high. Text should *appear* to be light relative to the background. Note that contrast should not be so severe as to be glaring and uncomfortable to read (Reynolds et al., 1978), such as with pure white on pure black. So, a certain range of colours are then available for text when the background is dark; light green, yellow, cyan or light turquoise, light orange, pink, light purple, light gray or white. Choices for background colours might be dark gray, dark brown, dark blue, dark red, dark green, dark purple and black. Combinations chosen should be appropriate to the subject matter. Neutral combinations seem to be the most successful in terms of keeping the screen less busy and keeping colours compatible. Light gray text on a dark gray background is probably the safest, most harmonious (with respect to other colours), combination for running text.

A brief look at colour processing in the eye is useful in determining which colours are easiest for us to see, and therefore which colours may be chosen or avoided. Different colours are focussed at different depths by the eye. For example, when viewing red and blue, red is focussed behind the retina and blue is focussed in front of the retina. This accounts for the illusion that red objects float forward and blue objects appear farther back on another plane. This also accounts for the fact that magenta may be seen to separate into two planes, one for red and one for blue. As these colours are focussed on different planes, viewers must work hard at refocussing various colours (Murch, "Visual accomodation and convergence...", 1983). Murch suggests that desaturation of VDT colours would reduce these refocussing requirements (Murch, 1984).

It has also been suggested that because of the problem of red and blue being focussed at such different depths, that these two colours in combination should be avoided (Sutherland, 1980). Red and blue (especially dark blue), are also somewhat lower in luminance, which means that on a dark background, contrast will not be sufficient for reading. Visual acuity is lower for red and especially blue (Reynolds, "Typographical and design considerations with viewdata", 1979). The visual system is particularly insensitive to the blue and to a certain extent the red area of the colour spectrum (Murch, 1984). Red and blue are therefore poor choices for text. Note however, that desaturation of red or blue, giving pink or light blue, should reduce the above described problems because the colours would then be closer to white. Note also that magenta may create problems with respect to separation.

On the other hand, the eye is most sensitive to the green and yellow area of the spectrum (Simcox, 1983; Davis and Swezey, 1983; Reynolds, 1982). This is why most VDT characters are green or yellow. These are safe colours for text presentation.

The other colours mentioned should be relatively safe choices for text, as long as they are high in luminance and perhaps not fully saturated. There are other considerations however.

Although coloured videotex text is considered more appealing than black and white text in subjective testing (Lester, 1984), too many colours on one page can create chaos. The screen may appear cluttered and the colours may be distracting when reading. To avoid "garishness", it is suggested that neutral colours such as light gray (which tends to appear white without the excessively high luminance of white), or a colour which is another shade of an existing page colour (especially green or yellow) may be preferable for running text. The number of colours used for text on one page should be limited, to keep the page "quiet". Two colours of text with varying luminance values should be sufficient for headings, emphasis, commands, main text and so on. When using colour for emphasis, only one colour change should be made and preferably only one item per page should be emphasized with colour change.

Pure white should be avoided as all three red, blue and green electron guns will be fully activated. Contrast will be extreme and colour alignment of the red, green and blue dots may be off, resulting in blurred or smeared characters. A light gray is a better choice.

So generally, very light neutral or compatible colours are acceptable. Pale green or yellow will be easy to read, but operators should be cautious that the page doesn't become too garish. Green and yellow would be good choices for titles. Red and blue (unless very light) should be avoided for text. Light gray is a safe choice for running text with some of the other colours used for headings or emphasis.

Chunking

Text that is grouped and segmented with typographical and spatial cues, in a manner which relates to the content of the text, appears to be easier to read and understand than nonsegmented text. This means simply that text should be grouped or "chunked" into units which are related, and separated by space from unrelated information, much the same way we do with tables. This is supported by research both for print (Hartley, 1978, 1980 and 1982; Waller, 1982; Green and Payne, 1982; Foster, 1980) and CRT text design (Tullis, 1981; Marcus, "Designing the face of an interface", 1982; Glenn, 1984; Reading, 1978; Davis and Swezey, 1983). As Haber and Wilkinson (1982) state, segmenting of text into meaningful groups with space is like flowcharting, where, "such a presentation visually organizes and structures the meaning of the passage.... This use of spatial location takes advantage of the capacities of human beings to use visual structure to organize any representation of knowledge." (p.28).

There is also agreement on the use of "chunking" with viewdata, although *shortage* of space limits the extent to which space may be used to separate information (Reynolds et al., 1978).

There is another reason why information should be grouped into chunks. Our ability to remember textual information is limited. Miller's famous research (1956) on the seven plus or minus two item buffer for short term memory, shows that humans are only able to remember, without a great deal of practise, about seven digits or words or points of information. If however, text or points are grouped, it becomes possible to remember about seven chunks of information. A simple list is given as an example in the course:

"Farm information includes, grain prices, livestock prices, machinery prices, daily weather, long range forecasts, news on feed, fertilizer and pesticides and more."

Chunking the list into three related groups makes it clearer and easier to remember:

"Farm information includes:
-grain, livestock and machinery prices
-daily weather and long range forecasts
-feed, fertilizer and pesticide news and more."

It now appears that the list contains three items rather than the original eight.

Another method of spatial cueing or chunking is paragraphing. The division of information into paragraphs or thought groups, makes it easier to understand. In an experiment measuring subjective reactions to page design in teletext, Champness and Alberdi (1981), showed that viewers found that the addition of paragraph indication to text, significantly improved clarity, usefulness, importance and meaningfulness of pages. The authors conclude that:
"Paragraphing is probably the single most important step in making a page readable."(p.2). Supporting research is cited.

Paragraphs can be indicated by indents or an extra line space. Only one method is necessary. Linespacing is considered preferable by some (Reynolds et al., 1978; Marcus, "Designing the face of an interface", 1982), as a method of indicating paragraphs, as the left edge is kept vertical, and the divisions are more evident. These recommendations also apply to long line lengths where it is especially important to break up the page with space. However, this method is too extravagant in terms of use of space, for videotex with running text at a line length of twenty to thirty characters. A small indent with no extra line space can perform the same function. Experience indicates that an indent of two characters is sufficient for paragraph indication, and that each page should have two or three paragraphs. More paragraphs would break up the text too much. Copywriters should be informed of this guideline for number of paragraphs.These recommendations for paragraphing should be confirmed through testing. It is likely that a small advantage of using line breaks over indents will not warrant sacrificing three or four lines of text to blank space.

Textual hierarchies
Within each page created, some information is more important than other, or must be read before other information (titles for example). It is up to the page creator to define levels of importance or a "hierarchy" for textual information, and to then organize the page in such a manner that the viewer reads the information in the desired order (Reynolds et al., 1978). This means, the page creator must create emphasis in certain areas of the text. As mentioned earlier, emphasis can be created through the use of colour change, size change or spatial separation. Reading order can also be controlled by the presentation order of elements on the page. These typographic "cues" should direct attention to the specific areas and can be used to structure headings, subheads, instructions, reference numbers, page numbers etc., in the desired order.

Reading (1978), suggests that a luminance hierarchy may be an option for establishing text dominance levels. The author's recommendations actually apply to the six teletext colours which vary in luminance levels. Although changing colour for every level of information might be chaotic, the idea of luminance coding would still work when using a single colour. As high luminance colours are lighter and brighter than their background, and are therefore of high conspicuity (Roufs and Bouma, 1980), text could be presented in one colour with varying luminance, according to

importance. In the course for example, running text and titles appear in very light gray (which appears white). Titles are separated by space to attract attention and consistently appear in the same position at top left. Secondary information, such as page numbers, section name, commands and reference numbers all appear in a medium gray. These reference items still have enough contrast with the very dark gray background to be read, but are clearly subordinate to, and less conspicuous than, the main text and titles. Section and page numbers display first, in case the reader wishes to check where they are, and then the title appears, followed by the running text. This shows how a variety of coding and emphatic devices can be combined to set up a hierarchy of what is most important and what text should be read first.

Textual hierarchies should be clearly defined, and structured using available techniques. Restraint should however be exercised in the use of emphasis or typographic cueing. It is not advisable to use too many options at once or to emphasize too many things. If everything is emphasized, nothing will be emphasized. Two or three methods of emphasis are sufficient, such as; space, luminance and display order; or size, space and display order; or colour, luminance and display order etc. There should not be an excessive number of levels in the text hierarchy. Information which holds similar importance such as reference information, can be grouped on the same level.

Blinking text
Blinking text is another method that could be used to create emphasis. However, flashing text is very disturbing to readers and has even been described as "obnoxious" (Merril, 1982). Although it is a very effective method of getting attention, it may distract readers from other important information. It is also very difficult to read blinking text. Its use is not recommended (Morse, 1979; Reynolds et al., 1978). Morse suggests that blinking an adjacent symbol close to the text may be an alternative. However, as the viewer proceeds to other information, the continuous flashing would still be distracting unless it stopped after a few seconds or the reader had the option to turn the blinking off.

Stacking text
Although videotex systems permit operators to vertically stack text, print guidelines suggest that this interrupts normal reading patterns and requires that readers decipher the word by spelling it out letter by letter (Dair, 1982). This method of labelling is very difficult to read and will presumably be very aggravating to viewers. Where possible, stacking of text (on graphs, charts etc.) should be avoided.

Scrolling text
Kolers (1980), conducted experiments on scrolling text on a CRT display and found that scrolled text can be harder to read than static (unscrolled) text, depending on the type of scrolling and scroll rate. "Jump" scrolling, where a text line is displaced upwards in single raster scans, replaced by a subsequent line, was found to be unanimously disliked. It causes readers to make errors and to lose their place. A smoother scrolling rate was also tested. Kolers found that performance improvement with scrolled text was dependant on scroll *rate*. Text scrolled at an optimal rate (20% faster than the reader's desired rate), improved reader performance significantly. However, if readers were allowed to set the scroll rate or if scrolling was slower than the optimal rate, the static page showed an advantage over the scrolled page. Kolers also cites research which suggests that "it is more difficult to reorganize or define for oneself a text that has been scrolled than a static text. Presumably the reader worries that the text will disappear, or the text does disappear before reexamination occurs." (pp.19-20).

NAPLPS videotex scrolled text is usually displaced upwards, in a jumping sweep which is very annoying and almost impossible to read. It is therefore recommended that scrolled text should not be used, unless smooth scrolling, set at an optimal rate, is implemented. This type of scrolling may be available on some decoders, but this should be verified before scrolled text is utilized in a page.

Summary
Text legibility and readability are extremely important with the videotex medium because it is so difficult to read and view. Text must be easy to see and understand. The screen should not be completely filled with text. Text should not be run from one page to the next.

Lower case lettering (with upper case at sentence and proper word beginnings) should be used for running text. Capitals may be used, if necessary for captions, titles or labels or for very long distance viewing.

Viewing distance should be considered in relation to text size. Large, ragged text sizes should not be used. Page creators should construct larger text, based on existing type faces. Self designed letters or DRC's should be used sparingly as they increase display time dramatically. The number of size changes in any one display should be kept to a minimum. Emphasis can be created instead, by use of colour change, size change or spatial separation. Colour emphasis should be used sparingly.

Text line length for running text in the standard smallest NAPLPS size should be about twenty to thirty characters long. For large text sizes, full screen width should be utilized, but space should be used to break up the page. Excessive hyphenation should be avoided. Line lengths should not be less than twenty characters unless text is a caption or title. If smaller text sizes are available, more conventional print guidelines apply for line length (fifty to seventy characters per line).

Text, including titles and labels should be arranged flush left, rag right. Text should not normally be justified, centered or randomly positioned. A pleasing, convex rag should be maintained on the right edge. Text should be *optically* aligned against the left edge.

Proportional spacing should be used. Wordspacing should be adjusted to reduce obvious gaps. Character counts should be prepared before text is written.

Sufficient contrast must be maintained between text and background. For running text, text should be light on a dark background. Text colour should be neutral or compatible with other page colours.

Text should be grouped and segmented into meaningful chunks with space. Paragraphs should be indented two character spaces with no line space. Textual hierarchies should be defined and established in the page.

Blinking text is not recommended. Stacking text is not recommended. Scrolling text is not recommended.

Medium unique aspects of text
CRT's are much harder to view and read from than print. Legibility and readability are far more important than in print. Videotex reading may also be quite different form normal VDT reading situations.

Character edges are not sharp as in the print medium. Text is very crude and very large. Font limitations are severe. Only a few sizes can be used. No italic exists. Other methods of emphasis must be used. Word spacing is unusually large and cannot easily be altered. Text line length for running text must be much shorter then in other mediums because of the text size and leading. The range of text options available with various decoders, is inconsistent. Page creators can design and in some cases invoke their own typefaces.

Screen space is restrictive. Spatial cues must be used sparingly. There is no room to use line spacing for paragraph breaks. Since space is limited, text preparation for the medium is unique. Text can not be run from one page to the next without losing the reader's train of thought.

Viewing distance will vary from user to user. There is usually only one viewer or possibly a few.

Luminance and flicker are major controlling variables in the presentation of text. As a result, light text on a dark background appears to be most suitable (unlike print). Light gray on dark gray seems to be the most suitable combination for running text. Coloured text

can contribute to display clutter. Contrast between text and background can be degraded by display device variations and environmental conditions. Text can be blinked or scrolled. Text can be changed in colour at no extra expense.

Time and display order are factors in the presentation of text. Self-designed text fonts and DRC's display at a very slow rate, so must be used sparingly.

Colour

Introduction

The electronic colours produced on a CRT monitor are very different from print or pigment colours. Colours are generated by a red, a green, and a blue electron gun in the monitor or TV, which illuminate the phosphor in the screen. These guns produce light which is perceived as the red, green and blue colours we know. All other colours are produced or mixed with the light from these three primaries.

This is an additive colour system. Light is added to produce the colours we see. If the blue and the red gun are active at the same time, the colour produced will be magenta. Green and blue produce cyan. Red and green produce yellow. Full activation of all three red, green and blue guns will produce the brightest colour, white. Note that each time light is added, the colours become lighter and higher in luminance.

This is an unfamiliar system of colour mixing to those accustomed to the conventional print or pigment primaries; magenta, cyan and yellow, or red blue and yellow. These mixing systems are referred to as "subtractive". Each time the colours are mixed, light is absorbed or filtered out and the colour becomes darker rather than lighter (Samit, 1983).

As videotex colours are additive, that is created with the addition of light, they are extremely bright. They are also normally very highly saturated with colour. As a result, pages have a tendency to become gaudy, invidious and confusing.

One of the biggest problems of creating videotex pages is the abuse of colour (Reading, 1978; Hum, 1982; McFarland, 1982; Reynolds, "Teletext and viewdata- a new challenge for the designer", 1979). There seems to be a certain novelty for using as much bright colour as possible. Presumably this fascination with the highly saturated colour is a result of the fact that colour bears no extra expense with videotex.

Page creators consistently use too much colour. Excessive use of colour on a VDU screen can create eyestrain (Samit, 1983). Murch ("Visual accomodation and convergence...", 1983). links the fact that colours are focussed at different depths, to eyestrain and fatigue when viewing multi-coloured displays. Engel (1980), points out that reading can be interrupted by the distracting, conspicuous colour. The eyestrain associated with luminance and flicker has already been discussed. These problems of garish display quality, refocusing of colours at different depths, distraction, and flicker can be compounded by lack of control over hardware display (monitor variations), ambient lighting conditions, phosphor deterioration and other technical problems (Bruce and Foster, 1982). It is clear that caution must be exercised when using videotex colour.

On the positive side, videotex colour does offer some advantages. As mentioned, the use of colour on videotex adds no extra expense. This is a great luxury considering print costs of adding colour. Colour can be utilized freely to create interest, code information and enhance viewer's acceptance and understanding of information. Videotex also provides the facility to experiment with a variety of colour schemes, again at no extra cost, prior to determining suitable display colours. On-screen testing permits full colour previewing. Page creators can redefine hue, saturation and luminance, without waiting for proofs or printing.

The extensive range of colours and luminance values available, can be used if necessary to make up for text font limitations (Twyman, 1982; Engel, 1980). Colour coding can replace italic and bold fonts normally available with other mediums.

Colour can generally be a valuable aid to improving communication with viewers. It should also be pointed out that videotex users find colour pages significantly more interesting and enjoyable to read and view than monochrome pages (Champness and Alberdi, 1981; Foster and Champness, 1982; Lester, 1984). As Samit (1983) states:

> Of all the reasons why color is so all-pervasive in computer graphics, the most important is that people react to colour. Although the use of black-and-white will sometimes suffice, it

is color that attracts, conveys meaning, elicits emotional response, and fosters the retention of information. Color is also a powerful persuader, and its use has been found to have a positive motivational effect. Tests have indicated that viewers *feel* they have a better understanding when images are displayed in color. People react to color positively if the presentation is visually and perceptually pleasing, and if it doesn't produce erroneous interpretations. (p.42).

Colour can certainly be used to the advantage of both information providers and users. It is an extremely important variable in the visual communication process.

Since videotex colour is additive, colour research for print is not directly applicable (Bruce and Foster, 1982; Foley, 1979). However, much can be extrapolated from colour research for colour VDT's in general, as colour is generated in a similar manner (with light), for all RGB systems. The only difference for videotex may lie in composite video or RF presentation of videotex colour on television. Further research with respect to this is required.

Hue, saturation and luminance

As mentioned, videotex colours may be defined by hue, saturation and luminance. Hues are the colour names which we normally use to distinguish colours. They are the blue, green and yellow identities we give to colours in our every day environment or on the colour wheel. Hues are perceived colours based on learning of colour differences. Hue is also sometimes referred to as chroma.

Saturation refers to how saturated with colour a hue is. If a hue is highly saturated, it is rich with colour. If it is less saturated, it becomes paler in colouring and eventually void of identifiable colour- a gray. Highly saturated colours may be referred to as "undiluted" (Rosenfeld and Kak, 1976). Pink for example is not as highly saturated as red.

Luminance actually refers to how much light is emitted by the colour on the screen (Murch, "Perceptual considerations of color", 1983). Luminance thus is usually measured intensity. As Murch points out, this is distinct from lightness and brightness. "*Lightness* is a property of an object itself, while *brightness* depends on the amount of light illuminating the object."(p.32). Murch also points out that brightness is experienced intensity as opposed to the measured intensity of luminance. In CRT colour, brightness and lightness are affected by luminance. These terms are confusing and are often interchanged.

Since NAPLPS colours are defined by luminance (as opposed to lightness or brightness), for the purpose of this project, luminance will be used as a blanket term to refer to how light or how dark colours are. High luminance colours will appear lighter and brighter while low luminance colours will appear darker and duller. This may be loosely compared to value- how light or dark a colour is. The highest luminance colour would be white. The lowest luminance colour would be black.

All three variables of hue, saturation and luminance must be carefully controlled. As discussed, use of numerous, high luminance, highly saturated colours can cause eyestrain and contribute to clutter and confusion. At the same time, sufficient contrasts must be maintained between objects or text, and their background. A healthy balance must be struck.

How many colours?

It has already been pointed out that page creators consistently use too many colours, which results in confusing, "messy" pages. The question then becomes, just how many colours should be used in any one page to best enhance and communicate the given information? Writers on colour VDT's and videotex unanimously recommend that colour be used conservatively, that is, that as few colours as possible be used in a colour, computerized information display (Davis and Swezey, 1983; Krebs and Wolf, 1979; Reynolds, "Typographical and design considerations with viewdata", 1979; Reading, 1978; McFarland, 1982; Hum, 1982).

If screen colours hold meaning or are used for emphasis, viewers may become confused by

multiple colour use. Cahill and Carter (1976), showed that search times of displays, for specific information, increased dramatically as more and more colours were added to the display. They also cite research which has shown a drop in target search times for displays with five codes or less. They do however, point out that if display density is low (few elements on the screen), and appropriately discriminable colours are selected, it may be safe to use up to ten colour codes.

Davis and Swezey (1983), claim that the maximum number of colour codes that should be used is eleven. Oda and Barker (1979), say four to eleven colours can be discriminated, but when brightness is constant, no more than four should be used. Krebs and Wolf (1979) state that: "The current literature suggests that no more than five colours should be used on operational electronic colour displays. An optimum number would probably be three or four colours." (p.12). They also point out that appropriate number of colours does depend on the task involved.

Reynolds et al. (1978), claim that only nine colours can be absolutely discriminated (although more can be discriminated if the entire colour set is present for comparison). They also present research by Haeusing which shows that six colours are absolutely identifiable. In another article, Reynolds ("Typographical and design considerations with viewdata", 1979) suggests that only four colours are acceptable for use in viewdata pages, and that ideally not more than three should be used. Note that this recommendation relates to the limited eight colour set.

It appears that if colours are to be used functionally, that only about four or five can be used with absolute safety in a given display. Since videotex pages tend to easily become cluttered and busy, and display devices vary so in their presentation of colour, an even more conservative recommendation is made for the use of colour on videotex. As a safety margin, the use of only three or four colours and possiby a range of grays is advised. Grays, black and white may be considered neutral and as such should not contribute to colour "clutter". In addition, a background colour (dark gray or a darker shade of one of the three or four chosen colours), may be required, especially if only three hues are initially chosen. Limiting the number of colours to only three or four appropriate hue choices will ensure harmony and unity, and will result in pages which are not "blinding". Addition of the neutral grays will provide the necessary flexibility for extra shading or highlighting. Harmony can also be created by selecting three or four shades of one or two colours.

The entire software course (with the exception of the section on colour), has been created using only blue green and yellow, plus minimal use of grays, black and white. It is not difficult to create images with only a few colours, and the results are harmonious and much less "garish" than when multiple hues are used. Although there is value in trying to portray objects in natural colour as an aid to recognition, viewers quickly adjust to representation of elements in only a few colours. Information about an object's identity may be carried in the value.

Limiting the number of colour choices should also speed image creation. It is strongly recommended that only three or four colours be used in an individual page or related series.

Colour coding

Colour coding simply means that similar information or "target" information is always coded or shown in the same colour for easy reference, like titles or page numbers. Samit (1983) points out that: "Repeated use of the same color for the same purpose develops a recognition pattern that will aid in faster comprehension." (p.43). If for example, instructions always appear in the same colour, the reader develops expectations for that colour. As soon as that colour is presented, the viewer will understand what the colour signifies. It has been shown that colour is a very effective coding device (Christ, 1975; Knapp et al., 1982). Christ shows that it is in fact superior to shape, size and brightness codes in a unidimensional task, and that only alphanumeric symbols are superior codes to colour in such a task.

Coding with colour is generally accepted as a useful way to group, separate or priorate information that the viewer is seeking in an electronic display (Reynolds et al., 1978; Teichner, 1979; Bouma, 1980; Oda and Barker, 1979). Examples of information that could benefit from the use of colour coding are; important text, instructions, recurring symbols or images, titles, references, page numbers, tabular material, indexes, background colours and so on. Krebs and Wolf (1979), in their description of principles for using colours in displays, suggest that colour coding is effective when used in four ways:

1. To assist in finding a specific symbol in a busy display.
2. As an informing or warning cue.
3. As a way to group related information and to separate other items.
4. As a way to increase visibility of an item or symbol.

Although Krebs and Wolf cite examples of colour coded aircraft displays, these recommendations seem to be applicable to other information coding.

They also stress the importance of consistency. Once colour codes have been established, they should remain constant. This consistency is especially important across a videotex page series. Pages can be colour linked. Once a colour scheme has been established, it should be strictly retained across related pages. This gives viewers a visual clue that each page is part of a larger whole and has a relationship to other pages. Colour coding a page series will add unity and help the reader to know where he or she is.

Colour coding could also alert viewers to a change in information. Information pages in a series would all have the same background colour. Title pages on the other hand could have a different background colour. (This assumes that there are enough other clues to visually relate the title pages to the series.) This would act as a "cue" to readers that a new topic is beginning.

As discussed in the previous section, information search time escalates as more colour codes are used in the display. The use of too many codes could create confusion. It is also important that colour codes used are distinguishable from one another. Recall that ambient room lighting and variation in display devices could make discrimination difficult (Reynolds et al., 1978). If colours are used for coding, they must be clearly different.

Colour interaction

Colours interact with one another to change our perception of colour. Albers' work on the **Interaction of Colour** (1975) shows us that the appearance of colours can alter dramatically according to the surrounding colours. Albers states that: "Colours present themselves in continuous flux, constantly related to changing neighbours and changing conditions.... Color is the most relative medium in art." (p.5-8). Albers' work was with pigments, but observation shows that similar interaction occurs with electronic colour. With respect to videotex displays, a selected colour on a page may appear different from the same colour surrounded by a different colour. A yellow surrounded by dark blue will appear different from the same yellow surrounded by pale green. This type of colour change is especially noticeable with grays surrounded by colours of different luminance values. This change is largely a function of contrast. The change in brightness according to background intensity is referred to as "simultaneous contrast" (Rosenfeld and Kak, 1976). Reynolds et al. (1978) present Ton's discussion of simultaneous contrast which explains the implications of this phenomenon for visual displays:

> Colours of relatively high and low luminance presented side by side appear respectively lighter and darker than if they were viewed separately, while adjacent colours of high and low saturation appear respectively more or less saturated than if viewed alone. The less saturated colour may be converted to achromaticity, or even to the complimentary hue of the more saturated colour. Complimentary pairs will appear more saturated and non-complementary colours will appear more different in hue, because of the

tendency of each colour in the pair to induce its after-image complement.(p.41).

For videotex then, if perceived colours do not remain constant, it may be necessary to make subtle adjustments to the chosen colours in a page to make them *appear* the same. This may mean altering luminance or saturation slightly to make a colour match. This is especially important for codes, as recognition of the colour is required to identify the code.

Light and dark colours
Light colours appear to come forward, while dark colours appear to recede (Samit, 1983). In print, white, yellow and other light colours are more noticeable on a dark background. We are accustomed to assuming that a light object is close and that a dark object or area is farther away. When an artist paints or draws, light and dark areas provide dimension to form and establish depth planes. With videotex, if the background colour is dark, high luminance, bright colours will appear more conspicuous. Teichner (1979) points out that this conspicuity is primarily a function of contrast between the light element and the dark background. This important principle can be used to create the illusion of an item being more, or less prominent on a page. As visual acuity is better with high luminance colours (Bauer and Cavonius, 1980), this information would be very legible. This principle then becomes an effective means of emphasis. Titles or important pictorial elements could be made more noticeable when rendered in high luminance, light colours.

Light colours will also appear somewhat larger than dark colours as a function of their surround (Goetz et al., 1982). A black square surrounded by a light colour and a yellow square of the same size surrounded by a dark colour will appear to be different sizes. This occurs in print and electronic colour. The phenomenon is accentuated with videotex because high luminance coloured light, will bleed outside the dots and appear to swell, while dots with less illumination appear to shrink in comparison. It may be necessary to alter the size of different coloured objects if they are to appear the same size.

Note that excessively high or low luminance will cause colours to appear achromatic, that is without hue (Reynolds et al., 1978). Page creators should also be careful that viewers are not distracted by elements which are light in colour, but which are not important.

Colour highlighting
In addition to using light colour for emphasis, change of colour can highlight information. If page elements are all one colour, an element in a different colour will certainly be conspicuous and therefore attract attention. Roufs and Bouma (1980) define visual conspicuity as, "the property of objects in their background, by which they attract visual attention and, consequently are easily seen." (p.258). They go on to say that this attraction seems to be dependant on difference between an object and its background.

Colour change could be used in graphics or text to highlight. For example, a bar graph could present several bars in one colour and a single bar in another colour to emphasize a particular year or amount. The prominent bar could be a lighter colour to bring it forward.

Caution should be exercised when making text passages in running text conspicuous, through colour change. Conservative use of colour in this instance will keep the page from being too distracting or disruptive to reading flow.

Colour area
It is more difficult to differentiate between colours when there is only a small area of colour (Oda and Barker, 1979). A dark blue line or dot may be perceived as black or an unknown dark colour. If that colour must be recognized, if say it is an important colour code or cue, it must be made larger or lighter or brighter, so it may be recognized as belonging to a particular colour set. Page creators should be careful that an item is large enough to identify the colour, if identification is required.

Colour associations
Certain colours have certain associations to people; red or yellow mean warning or caution, blues and greens are associated with nature, pink and blue make us think of babies, blues

and grays are very formal and sedate, and oranges and yellows tend to imply warmth and lively activity. The colour scheme selected for pages should relate to the subject matter and page objectives. If pages are for business or serious subjects, sedate formal colours should be selected. If pages are games for children where attention must be attracted, lively, bright colours would be appropriate. Colours can create a certain mood and reinforce a particular message. Colour selection should be appropriate.

Luminance, flicker and contrast

Luminance, flicker and contrast have all been discussed in the section on text. A brief review follows. Luminance is the amount of light emitted form the different colours on the screen. For the purposes of this project, luminance may be used as a term to denote value, since high luminance colours appear lighter while low luminance colours appear darker. (Note however, that desaturated colours can also appear lighter and that certain hues are of higher or lower luminance than others, meaning that some hues are lighter or darker than others.)

Generally, high luminance colours have more light and must be used with great caution. As Cakir (1980) points out: "As a general rule, the brighter, the more dense and the larger the display, the more noticeable is the flicker."(p.108). Flicker is the "jitter" of the screen image created by the refreshing of the phosphors with light at a fixed rate. The use of numerous, high luminance colours especially in large areas, such as a background, make flicker more noticeable and more irritating. Highly saturated colours also project more light, and aggravate this problem. Use of several high luminance, highly saturated colours, especially in large areas, should be avoided.

With respect to contrast, Rosenfeld and Kak (1976) state that, "a region must be at least partially surrounded by edges (i.e., abrupt changes in luminance); if it is not, one cannot see it as an individual entity."(p.57). In order to see objects as well as text clearly, it is important that sufficient contrast be maintained between elements and their background. It should be remembered that contrast is *not* determined by colour difference, but by light/dark difference. To make an object distinct from its background or surrounding colour, it must be considerably lighter or darker than the background. Colour pairs with similar luminance and saturation will not provide sufficient contrast. Note however, that a page full of extreme contrasts (i.e., black and white, black and yellow etc.), can be too harsh and busy.

Colour selection

With so many colours to choose from and with the option of varying saturation and luminance as well as hue, it is difficult to make recommendations for specific, successful colour combinations for videotex page creation. Much has been written on perceptual aspects of VDT colour and on print colour theory, but little has been said beyond common colour associations about *what* colours should be used. Again, considering the lack of research in this area, one can only make some general suggestions as to what colour groups may be appropriate, and what colours should be avoided.

The use and selection of colour may be considered from both a functional and an aesthetic approach. Both should be considered when creating pages. The functional use of colour, as in coding, creating hierarchies, highlighting, linking and establishing contrast has been discussed. Recall that selection of specific colours should set moods and reinforce or relate to content. When colour codes contain meaning, colours should be distinct from one another. Recall also that, our visual systems are most sensitive to the yellow and green area of the spectrum, and that visual acuity is poorest for blue (although altering saturation or luminance can change the nature of these colours). Colours are focussed on different planes; red in front, blue in back, and green in the middle. The red and blue planes tend to separate out of magenta.

With respect to maintaining contrast, the first recommendation for selecting colours is to choose an appropriate range of light to dark colours. As the page at best, should contain three colours only, *a light, a medium and a dark*

colour should be selected to work with. This is likely the most important aid to colour selection. This will insure that colours stand out from one another and that a hierarchy of three levels of prominence is established. In addition, grays (including black and white), and a background colour (a dark shade of one of the selected colours) could be added.

Beyond these important functional considerations, colour selection becomes an aesthetic decision. Pleasant colour combinations can make the screen easier to view, and can create a sense of harmony within and across pages. Certain colour combinations are more compatible or harmonious than others.

Some of the more pleasing combinations can be derived from the hue hexagon. The pairing of complementary colours (direct opposites on the hue hexagon), such as blue and orange or violet and yellow or green and magenta, is a simple harmonic choice. Groups of three colours from half of the hexagon or less, such as violet, magenta and cyan, or green, yellow and orange also work well. Use of all pure hues can be garish (unless saturation and luminance are carefully controlled). Another alternative is to select one hue and vary saturation or luminance to give one tone to the picture (Baldwin, 1984). This is not effective however, if colour codes must be clearly discriminable. Colours in the same tone, although pleasing to view, will be difficult to distinguish from one another. Two colours beside each other on the hexagon and a third from between the two colours, such as red, yellow and orange are also a pleasant combination.

It should be remembered that a light, a medium and a dark value should be rendered from the colours selected. Background colour could be dark gray or a dark tone of any one of the colours selected for the page. Note that there may be some problems created by working with red and blue in the same display, depending on luminance and saturation. Reds may "pop" forward on the screen and blues recede.

Based on experience, some colour combinations which seem to be effective and harmonious may be identified. The following colours represent a light, a medium and a dark colour selection, plus a fourth colour option (in brackets):

- yellow, orange and dark blue (plus green)
- yellow, orange and dark red (plus gray)
- yellow, green and dark blue (plus cyan)
- gold, green and dark brown (plus rust)
- cyan, pink and dark blue (plus mauve)
- yellow, orange and dark green (plus lime)

Dark gray is a good background colour for any text colour. Light gray on dark gray is likely best for running text. Other combinations for text and background colour are also suitable especially when small amounts of text are presented or when only one or a few pages are being viewed. For example:

- light gray on dark blue
- light green on dark green
- pale yellow on dark brown
- cyan on dark blue
- turquoise on dark teal
- light orange on dark brown
- beige on dark brown
- pink on maroon
- yellow on dark green
- light orange on dark green
- light green on dark blue
- pale yellow on dark blue

Page creators should seek colour harmony and select colours which are pleasing to view. Great restraint should be exercised with respect to number, brightness, and contrast of colours used. Colours may be greatly distorted by the time the user sees them. Differences in decoders, monitors and televisions, broadcast distortion, and ambient room lighting can greatly affect how accurately colours are reproduced. Where possible, colours should be previewed on the display device.

Summary

Colour should be utilized on videotex, as it improves viewer impression and understanding of pages. Caution must be exercised however, when using colour. It must be used very conservatively. Page creators should avoid using too many colours. Pages should contain only three or four colours (in addition to the background colour and grays). Hue, saturation

and luminance must be carefully controlled. Use of a lot of high luminance, highly saturated colour, should be avoided. Large areas of light colour, especially white, should be avoided, as they make flicker more noticeable. The display device should be considered. Colour schemes should be pretested on screen.

Sufficient contrast between objects and their background should be maintained. However, a page full of extreme contrasts will be difficult to view. When the background is dark, light colours should be used for information which is to be highlighted or made prominent. Page creators should avoid distracting the viewer with brightly coloured information which is not important. Text colour change should not be so conspicuous as to interrupt reading flow. A light, a medium and a dark colour should be selected to work with on pages.

Similar information should be colour coded. Colour codes and scheme should be retained across related pages. Number of colour codes should be kept to a minimum. Colour codes should be distinguishable.

Necessary colour adjustments should be made to compensate for colour and size change caused by surrounding colour interaction. Colour area will affect colour identification.

Colours selected should be appropriate to the subject matter and the objectives. Page creators should strive for colour harmony.

Colour can be used to make up for font limitations.

Medium unique aspects of colour
Electronically generated colours are very different from print colours. Videotex colour is additive rather than subtractive. Colour theory for print is therefore not directly applicable. VDT research must be consulted.

The eyestrain associated with viewing electronic colour is a significant problem. The brightness of the colour dictates that it must be used much more conservatively than print colour. Fewer colours must be used to keep the screen from becomimg cluttered and garish. Only three or four colours (in addition to the background colour and the gray range), may be used effectively with this medium.

Luminance, saturation and flicker are extremely important variables. Large areas of high luminance, highly saturated colour must be avoided because of flicker. White must be used sparingly. Viewers can be easily distracted by high luminance, highly saturated coloured information, which is unimportant.

The medium permits on-screen testing of colours with immediate results, without the expense of proofs or comprehensives. Colour can be utilized freely, within the guidelines presented, because their is no extra cost involved. Colour can be used to make up for font limitations. Colour reproduction is however, inconsistent, depending on hardware, ambient lighting, phosphor deterioration and so on.

Page colours can not be compared side by side. They must be viewed in isolation. Colour coding or linking acrosss a page series becomes vital to connecting unseen pages. This page isolation also permits a certain leeway for colour correction (necessitated by the effects of colour interaction), as colours can not be directly compared between pages. Rather, colour appearance is dependant on viewer memory. A subtle adjustment will not likely be noticed.

Form

Introduction
Form can be defined as, all non-text shapes, lines, pictures, symbols and images. Videotex provides complete capability for picture creation, using the geometric primitives.

There is skepticism on the part of many outside the field of art and design about the value of using pictorial elements for the delivery of information in both print and computer graphics. However, research clearly shows that pictures are processed, stored and recalled by humans far more efficiently than textual information (Standing, 1973; Lodding, 1983; Haber, 1970; Huggins and Entwisle, 1974). Huggins and Entwisle in **Iconic Communication** suggest that we think visually rather than verbally. When we look at things we remember them in terms of where they are in relation to other objects, by what shape or volume they had, by distinguishing markings and so on, not by their verbal name or identity. We are cognizant of these visual features and relationships from a very young age, without special training. Huggins and Entwisle point out that children navigate a complicated path to school without problem, but are unable to give verbal directions on that route. This is because, this spatial orientation is dependant on thousands of visual images and relationships stored for review at will, as opposed to a stored language description of the route. When we remember where we left our gloves, we picture them visually, on a shelf in a particular closet, next to a shoebox. We remember faces better than names. Huggins and Entwisle go on to explain, that language is dependant on complex learning, acquired through years of instruction, whereas, iconic images are processed through primitive visual skills and cognitive processing not dependant on the kind of learning required for written information.

It seems that we have two different memories: one for linguistics, and one for pictures (Haber, 1970). Our memory for pictures is much better than our memory for words. Our memory for pictures is in fact almost limitless. In a test conducted by Haber (1970), subjects showed 85% to 95% correct recall of pictures from a previously viewed group of *2560* slides. Subjects were even able to recognize pictures which were projected in reverse. Unbelievably, a test by Standing (1973) three years later, using *10,000* pictures yielded similar results. Standing showed that our capacity for recalling visual images is clearly superior to word retrieval. This research suggests that connecting/relating images to words, may effectively improve recall of information (Haber, 1970).

This is significant in the terms of the communication of information with computer graphics systems. Information providers may derive great benefit from this knowledge especially when it comes to essential information or product marketing. Pictures and spatial orientation may be very important to the ability of viewers to retain information shown to them. Haber and Wilkinson (1982) conducted an experiment comparing recall and recognition of a pictorial flow chart version of a sponge cake recipe, as opposed to a conventional, cookbook presentation of the recipe. In all respects, subjects showed better performance with the pictorial version. A similar test comparing a visual map of a city route and verbal instructions showed the same results. The authors stress the importance of this knowledge to computer display of information.

Pictures serve important functions. As shown above, they can lighten the processing load for humans and aid retention of information. They can be used to communicate information and to reinforce content. They can attract, direct and hold, attention and interest. They can break up and relieve otherwise monotonous text.

For videotex, pictures can in fact save valuable space by replacing a lengthy written explanation of a concept with a pictorial translation. Pictures are more "compact" (Kolers, 1969). A picture *is* worth a thousand words. They can lend form and structure to invisible processes, as in diagrams or charts, which would be difficult to explain verbally.

Pictures should not however, be used exclusively without text. Although pictures are processed, stored and recalled very efficiently, text is better for absolute accuracy (Booher, 1975). Text and

pictures should work together. Nievergelt (1980, p. 16) points out an advantage of using computer form to illustrate text; "figures don't need to be numbered. When you want to refer to one, just reproduce it." Finally, pictures provide a system of communication largely immune to language differences- they are understood universally (Easterby, 1970; Huggins and Entwisle, 1974).

Do videotex users have subjective preferences for pages containing graphic form as opposed to straight text pages? Lester (1984) investigated preferences for informational graphics on videotex pages and found that subjects unanimously preferred a graphic page to a text-only version. In Champness and Alberdi's (1981) tests on subjective reaction to teletext page design, the authors discovered that subjects found graphic pages significantly more *attractive* than text pages. Other videotex trials confirm that users respond favourably to graphics/pictures. (Toombes, 1983; Elton & Carey, 1983).

It is clear that the use of form in videotex is important. Creating videotex pictures does not however, come without difficulty. Technical limitations are again inhibitive. Poor resolution results in "ragged" images which require patience and creative imagination to convert to sleek, professional looking pictures. Cost factors (page byte length) prohibit the use of any level of detail. Consequently pictures must be stylized and simplified: no easy task for a "non-artistic" page creator.

In addition, if misused, form can effectively distract viewers from other important information. Conspicuous decoration which serves no function and contains little meaning can elicit negative reactions from users.

Point, line and plane

All forms are constructed from points, lines and/or planes. Videotex forms are all constructed from "dots" or pixels of light on the raster CRT screen. These screen dots join to make lines and planar forms such as circles, rectangles and polygons. These geometric primitives are very convenient for constructing pictures. A layman can produce a perfect circle or equilateral triangle almost instantly without measuring and without special equipment. This enables operators to build images piece by piece with some sense of regularity of form. It is in fact preferable to use these geometric forms rather than available "sketch" functions. A sketch feature permits freehand drawing, but unless the page creator is very skilled at drawing, results are unprofessional. Also the sketch feature is not economical because elements are constructed and displayed point by point and the bit load is exorbitant. The geometric primitives such as the arc or rectangle, on the other hand display almost instantly. Use of a sketch feature should be limited. If it is used, the image can be traced and replaced with a polygon to hasten display time.

Rules

Lines or rules are effective devices for dividing, enclosing, defining, grouping and organizing space and information. Rules can separate a title or references from text or can define a block of working space for specific information. Rules can organize and divide tabular information. They are useful aids for clarifying structure of text in relation to its meaning.

The use of rules to define neat blocks of space, can also impart a sense of order and regularity which will help to keep pages from becoming cluttered. In order to promote this sense of quiet order, rules must fit the predefined grid. If a rule is positioned between title and text, it should extend the full length of the column or page. Lines which extend out of the grid or fall randomly within the grid will create clutter, and in fact disrupt page order.

Underlining of words and phrases to create emphasis should be avoided, except in special cases such as bibliographic underlining, (where luminance value of the rules should be kept low). Colour underlining generally clutters up the page. Colour change, or spatial separation is a better way to create this kind of emphasis. Luminance value of all rules should be kept low so that they do not become more conspicuous than other page elements. If rules are conspicuous, the page will also become busier. It is not necessary to change the rule colour,

just the luminance value. Keeping rules in the same colour tone as the text or page colour scheme will promote harmony.

Audience experience

"Our minds make sense of pictures -- as well as real world scenes -- by fitting them to existing mental 'schemes' or 'prototypes'..." (Mills, "Evaluating the impact of videotex images", 1982, p. 266). The pictures that people will recognize and understand depend on their individual and/or cultural experience (Kolers, 1969; Haber and Wilkinson, 1982). Page creators must make certain that their audience will understand the images he or she may take for granted. Many pictorial images are universally understood, but some will only be understood by a particular group. For example, we may well know what a human head with a light bulb in it means, or we may recognize the laundry symbols on clothing label, but this does not mean that a person from another culture will comprehend those symbols, which are unique to *our* culture. Within our own culture, certain icons will only have meaning to certain groups. The symbol for radiation for example may not be recognized and understood by everyone. Pictures and symbols used by the page creator should conform to population stereotypes or habits which are well established (Davis and Swezey, 1983). When meaning is in doubt, page creators should show pictures to users to see if they are understood.

When to use form

When is a picture worth a thousand words? We have already seen that form can be processed, stored and recalled easier than text, and that it can help to reinforce information presented in text. What happens if the form does not carry any information or if it carries information which has no relationship to the content of a page? Meaningless or irrelevant visual information results in "just another pretty picture" a phrase which has historically been very detrimental to the development of effective information dissemination through the use of pictures. Form that is purely decorative imparts very little to viewers in the way of information. Irrelevant form can also be distracting.

Probably the single most important criterion, for using form, is that it should serve some function or purpose; to explain, illustrate, provide information, establish a theme, etc. Every effort should be made by page creators to avoid *decorating* pages. Ornamental embellishment will clutter the page, detract from important information, increase display time and take up valuable information delivery space. Instead, form should be applied for useful purposes such as; clarifying a process, illustrating a point, directing attention, showing change or flow, showing how a person or component fits into a larger system, giving visual structure to invisible processes, organizing information, defining a topic, summarizing, simplifying abstract concepts, explaining instructions visually, and generally aiding comprehension and recall. Marcus (1980) adds to the list of functional form; form should be used to convince, elaborate, amuse, construct, demonstrate and report theory, show ideas, structure arguments and create narratives. Mills ("Cognitive schemata and the design of graphic displays", 1982) recommends that form be used to show "what" and "how". A picture can illustrate *what* something looks like (identification and relationship) or *how* something operates (time, motion and relation).

This is not to say that aesthetics are of no concern whatsoever. All images used should be neat and aesthetically pleasing. Form can also be utilized to relieve monotony, entertain, attract and hold interest or set a mood. These to are functions. However, there is no reason why the imagery that is being used to perform these type of functions, can not contain useful information. Form *must* relate to the content in a meaningful way.

Do viewers care whether graphics are informative as opposed to purely decorative? A 1982 study by Tombaugh et al. where users evaluated videotex graphics, showed that: "Drawings which illustrated the text, and those which explained the text received better ratings. Those unrelated to the text or used as decoration were poorly rated." (p. 343). The authors conclude that information providers should use graphics which relate to the written content rather than just "decorating" pages. In

the results published for subjective testing showing preference for informational graphics pages over text pages, Lester (1984) claims that informational graphics such as maps, graphs and charts will be of greater value to users than decorative graphics, as they are less boring and more informative.

Note also that Champness and Alberdi's (1981) subjective testing of teletext page design, reveals that while graphics may be rated as attractive, the rated usefulness and clarity of those same graphics may be quite different. It stands to reason then, that graphics should be useful or informative *and* attractive, as opposed to just being attractive.

Page creators should ask themselves what purpose the form they wish to use, serves. If it serves no function it should not be used. Page creators should pinpoint ideas in the text which would benefit from a visual explanation, illustration, or reinforcement, or which need to be visually remembered and recalled. Form creation should be based on content and function.

Simplicity
Once useful visual concepts have been identified, the page creator needs to know how pictures should be formed- what characteristics the images should exhibit. Dondis in her book **Visual Literacy** (1973), provides a useful list of formal characteristics of functional form:

-simplicity
-symmetry
-angularity
-predictability
-consistency
-sequentiality
-unity
-repetition
-economy
-subtlety
-flatness
-regularity
-sharpness
-monochromaticity
-mechanicalness (p.144).

The aptly placed item at the top of the list, is the most significant feature that functional form should demonstrate. In fact most of the characteristics listed relate to simplicity of form. Simplicity is is fact the most important aspect of videotex form creation.

Unfortunately, some information providers are fascinated with simulating realism with videotex. People are often easily impressed with highly artistic illustration. We have already pointed out that viewers prefer graphics which contain information and are useful. When it comes to the delivery of information, the use of detailed realism may not be the best or most appropriate technique for picture creation with videotex. There are five reasons why simple images may be better for videotex:

1. The first reason has to do with perception of pictures. One definition of simplicity presented in Arnheim's book **Art and visual perception,** (1974) states that the smaller the amount of visual information needed to define a visual organization (i.e., number of angles, number of different angles and number of lines), the greater the likelihood that that unit will be perceived. The visual system is particularly sensitive to angles (Noton and Stark, 1971). Images or objects which have multiple elements, intersections, overlaps and so on increase the processing load for the viewer. The perceptual system must make more false starts in its perusal of a detailed picture, which means, it takes longer for the viewer to recognize the element. (Mills, "Evaluating the impact of videotex images", 1982). In his extensive investigation of human response to pictures on Telidon, Michael Mills (**Telidon behavioural research 3,** 1981) shows that simple drawings, like cartoons or caricatures may well be far easier to recognize and read than more detailed images. Mills presents research supporting this and suggests that "reductionism" involved in simplifying these types of pictures makes them easier to encode to fit to our existing idealized or prototype schemes for storing visual scenes. We do not store pictures in memory photographically, but rather we extract and emphasize important features (Kolers, 1969). Mills concludes that simplified pictures may be more effective than detailed realism for videotex.

There seems to be general agreement on the notion that recognition and interpretation of pictures is perceptually easier and better for simple images than for detailed pictures in print and computer graphics (Kolers, 1969; Rosenfeld and Kak, 1976; Morse, 1979; Lodding, 1983).

2. When we simplify pictures, we exercise visual "editing". While a realistic simulation shows all aspects and details of an object or scene, a simplified version of a picture edits out unimportant detail, and focuses on information or properties relevant to a specific message (Arnheim, 1974). Viewers are not distracted by irrelevant detail, and because there is a minimum of information to view, meaning is conveyed quickly. A good example is given in the course. If one wishes to visually instruct a user to insert an item in the mail, the message is much clearer if one "zeros" in on a hand passing a letter into a slot marked "mail", than if one shows a girl with a ponytail and striped runners with a load of books under her arm and a letter in the other hand walking by a tree with apples, by a brown building with a smoke stack with a bird flying by, towards a detailed street mailbox. Reduction to the essentials improves clarity.

3. Simple form is more suited to the videotex medium. Images must be constructed from basic geometric forms. Resolution is normally very low. Curvilinear elements, detail, elaborate shading and "realism" are difficult, and time consuming to execute. The regularity of the geometric primitives is conducive to more "stylized" pictures. These medium unique features should be used to advantage. Page creators can focus on specific aspects of pictures, analyze basic areas of light shade, and colour and streamline those areas by assigning appropriate simple planes, lines or shapes, instead of trying to use the primitives to sketch and insert every detail. An uneven ellipse-like shape can be reduced to a circle or smooth ellipse. A highlight can be produced with a simple dot or square of white. Messages become very graphic, and the operator works with the medium rather than against it.

4. Simplicity is also more suited to unskilled operators. Detailed, realistic illustration can only be created by an accomplished artist or illustrator. Most page creators do not have these skills. Attempts at illustration by unskilled operators yields very awkward and unprofessional results.

5. Finally, and perhaps most important, simple pictures take less time to display than detailed pictures. It has already been pointed out, that viewers consistently find lengthy display time aggravating. In the detail versus time tradeoff, viewers will almost certainly prefer simplicity (Dillon and Tombaugh, 1982).

Therefore, it is recommended that videotex pictures generally be kept simple. Images should have flat shapes, regularity, directness, should be reduced to the essential information, and should be somewhat stylized. Pictures should be geometrically based; composed of simple rectangles, polygons, etc. and constructed using mostly verticals, horizontals and 45 degree angles. A review of Dondis' characteristics of functional form presented earlier, will provide further features to strive for in the creation of simplified form.

Not all pictures should be simplified. Some visual information will require detail essential to delivery of a specific concept. Instruction is one example of a task requiring certain levels of detail for certain topics. Also, in videotex shopping, it may be necessary for consumers to see the details of an advertised product in order to make a purchase decision. Other instances will occur where some detail may be required, but again the choice whether to use it should relate to function. A decision must often be made between function and economy.

It may be argued, that detailed illustrations can be considered "works of art" or useful in terms of "entertainment value". Whelan (1982) comments that these pictures, for the sake of pictures, although they may be initially "attractive", are "rarely worth more than a single look... and few customers will be prepared to spend money viewing such pictures."(p.129) If users are paying for information by the page, as is often the case, they may prefer useful information. Even if a detailed "art" picture is not being paid for, one

must ask if the extra display time is warranted. This probably depends on the viewers' interests and motivation. It is likely that once the novelty of elaborate graphics has worn off for new users, they will be more interested in useful pictures (Sutherland, 1980).

It is important to note that simple does not mean "simplistic", in the sense that the picture is so pared down as to be invidious and ambiguous. Page creators should strive to make pictures aesthetically pleasing, and sophisticated in their presentation. Bad pictures which are so simple that they are crude, will certainly have a negative effect on perception and attitude. Usually, simplicity, aesthetics and function are intrinsically related, and page creators will find that one comes with the other. Page creators should set high quality standards for form creation, and not use simplicity solely as a short cut to picture making.

Linear versus solid shapes
In keeping with the ideal of simplicity, one must question whether it is better to use linear drawings or solid shape drawings. The area of pattern perception provides valuable information on what characteristics make form more perceptible or discriminable; this research shows that closed figures are superior to open ones, continuity of form aids perceptibility, symmetry, simplicity and unity help perceptual organization, and contrast bounded figures (solid shapes) are superior to linear form. Forms which are constructed from thin lines, with little contrast between the line and background will be weak and unstable. A solid object or an object with heavy lines or contours will be more stable and clearer (Easterby, 1970).

Consider that, linear drawings will increase the number of intersections, overlaps and angles appearing. As mentioned earlier this increases the processing load for recognition. Also, the nature of the videotex medium is such that solid shapes are easier to work with than sketch lines. If one adds the evidence from pattern perception research, it seems reasonable to assume that solid shapes are better than linear drawings for perception, and that if linear drawings are to be used, the lines or contours should be thick, contrasting heavily with the background.

In addition, the use of linear drawings substantially increases the overall "busyness" of a videotex page as compared to the use of flat solid shapes, especially considering the extra visual "noise" created by linear "staircasing" or "jaggies". Solid shapes also create a more graphic and dynamic visual statement.

Page creators should avoid the use of thin (one pixel wide) lines for creating pictures and should use solid shapes where possible. Also it is not necessary to outline shapes in addition to presenting a solid shape. This is redundant and will only make the image busier. Linear versus solid shape videotex drawings should be tested to confirm this hypothesis.

Symbols and pictograms
A pictogram may be defined as a picture that represents an actual object, action or concept in a simplified or stylized form. Pictograms are usually well known images that are quickly recognizable and made from simple geometric shapes. An example would be a sign with a streamlined coffee cup on it to represent a coffee shop, or a shoe to represent shoe stores. A symbol may be defined as an *abstract,* mark or form that is not representational, but that symbolizes something. An example would be the yellow triangle sign used to indicate caution. Symbols must be learned.

Symbols and especially pictograms are the ideal imagery for use with videotex. They can be used to illustrate broad concepts effectively without the use of a lengthy description. For example, disk insertion in a computer could be explained with the use of a disk drive, disk, hand and arrow symbol all in simplified form. Symbols and pictograms are particularly well suited to this medium in terms of ease of creation, and geometric construction.

Pictograms and symbols can also be used as codes, to designate topics or change of information. For example, a simple plant form could denote a section on garden tips or a hospital cross could signify first aid information.

Abstract symbols must be used cautiously as viewers must be familiar with the meaning or have the meaning explained. Pictograms are more easily understood (Diethelm, 1974).

A formula may be defined to assist the page creator in the development of pictograms. Here follows a description of this problem solving method. (This method is loosely based on Bedno's (1972) program for the development of visual symbols).

1. Write down the idea/concept to be represented. For example:

A) farm information
B) oil and gas activity
C) bad weather
D) gasoline prices

2. Write down all the possible words, ideas and objects associated with the specified topics (as many as possible). For example:

A)tractor, animals, barn, silo, grain etc.
B)pump, derrick, gas pump, oil truck etc.
C)clouds, snow, lightening, tornado, rain, etc.
D)gas pump, dollar sign, service station, etc.

3. Sketch all of these ideas and items (or parts or combinations) on paper.

4. From the sketches, select the simplest picture which communicates the idea best.

5. Eliminate all detail except what is necessary to make the idea clearly recognizable.

6. Streamline the shapes. Construct the pictogram from solid geometric shapes or heavy outlines in 2 or 3 colours.

7. Ask a neighbour what it represents.

Results for the above examples might be:

A) a simple barn with a silo
B) a simplified oil pump
C) a dark cloud with a lightening bolt
D) a gas pump nozzle with a drip and a dollar sign coming out of it.

When creating pictograms, page creators should be aware of certain guidelines: Pictograms should be meaningful. There should be no unwanted meaning. They should be constructed from simple geometric forms. Solid shapes or very heavy outlines are best. The pictogram should be a closed unit. (It can be put in a square or circle.) Unnecessary detail should be eliminated. The pictogram must be recognizable. There should be no ambiguity. Horizontals, verticals and 45 degree angles should be used to construct the pictogram.

Graphs

Although the subject of graphs, (and also tables, charts and diagrams) is a whole topic unto itself, some general recommendations can be made for graphs, with regard to the previously discussed topic of simplicity and pattern perception. Graphs can effectively visualize data in such a way that it is understood and used more quickly than tables (although maybe not as accurately) (Reynolds et al., 1978).

The videotex medium is effective for the creation of bar graphs from simple rectangles. It is weak in terms of the number of variables and the amount of text that can be used on a graph. In terms of communication, this space restriction is not necessarily a drawback (except for text). Probably the most important aspect of graph creation is to use the graph to make one point and one point only. If for example the point to be made is that unemployment is higher in Alberta than in Ontario this year, then *only* that should be shown. It is not necessary to show other provinces or other years. Originators should be asked to only put forth one idea with each graph.

When creating the graphs, the most important elements should be the most conspicuous. Items of lesser importance such a rules and variable text can be in a lower luminance colour so the graph doesn't become too busy.

Solid colour areas should be used. Busy linear textures and outlines will make the graph cluttered. If there are not enough solid colours to fit the variables it is likely that too many things are being shown. If a line graph is used,

the line should show heavy contrast, that is be at least two pixels wide. Only 2 or 3 lines at most should be used and each should be labeled on the line (Reynolds et al., 1978). Thin lines and indeed linear textures are weak, "messy" and difficult to discriminate. Trends are best shown with line graphs, followed by vertical bar graphs, because horizontal bar graphs imply a time dimension (Penniall, 1980). Graphs should fit the grid. Further recommendations for the effective use of graphs are beyond the scope of this document.

Depth and volume

It is possible to create the illusion of three dimensional form with two dimensional images. Wong (1972) refers to this as "illusory space". We can create illusory space because our perceptual system is organized to accept certain cues which distinguish between objects in our environment and their surrounding space. These cues come about as result of the fact that the shapes we see, interact with surrounding shapes (Arnheim, 1974). If for example, one person is pictured standing in front of another, they will appear respectively as close, and farther away. If only one person is depicted, there is no cue as to that person's position in space, unless other objects, lines, or shapes interact with the figure to give us information about depth in space and form.

The illusion of depth in form and space can be created by overlapping, changing size, changing colour, changing view, curving or bending, using shadow or with converging lines (Wong, 1972). An example of overlap has been described above. If one plane overlaps another, a sense of space is immediately created. In size change, from small to large or large to small, as with trees which get progressively smaller in the distance, we also feel an extension into space. We have already discussed the fact that light colours come forward and dark colours recede. Objects which go from light to dark will be seen as receding into space. A cube viewed from one side straight on will appear as a square. If the viewpoint is shifted, other parts of the cube become apparent. These parts also act as cues to volume. If a simple square is curved or bent, it will be seen to be coming forward or curving backward. An object which throws a dark shadow will be seen as having volume and occupying a position in space where there is a light source. Finally, converging lines as we see in a receding railway track, will simulate a three dimensional space.

The manipulation of illusory space can be used to help make items of importance "pop" forward on the picture plane. It can also add interest to drawings. The use of the 45 degree angle makes it easy to extend objects back into space, without calculating complicated perspective. Shadows can be easily cast by repeating an object in solid black underneath and in a slightly different position than the coloured object in the forefront.

These devices described do however, complicate videotex pictures, especially if the page creator trys to simulate realistic three dimensional form. The addition of depth and volume should be used only when flat forms do not provide sufficient information, or when the aesthetic appearance of a drawing can be significantly improved without adding greatly to display time. It is possible to use these devices sparingly in an effective manner, if the operator is skilled.

Fill values

Videotex fill values offer a range of textures and line patterns which may be overlayed on solid colour areas. They are used frequently for shading or for graphs. Unfortunately, these textures, created by the repetition of lines, contribute to the overall "visual noise" on a page and as dicussed earlier, increase the perceptual processing load. It has also been shown that elements coded by colour or at least colour and texture are superior to symbols coded only by texture in search tasks. Detection of points is also easier on a solid colour background than on a textural background. Although texture codes may be a little easier to remember, the difference, if there is any, is small (Phillips and Noyes, 1980). With the range of colours and grays available, it is not necessary to use textures for shading or coding. Grays or darker or lighter versions of display colours can be used for shading. If more than 3 or 4 colours are needed for coding as in graphs, too many codes are being utilized.

Most important, videotex textural fill values usually take an inordinate amount of time to build up on the screen. This very slow build up makes their use totally impractical. The use of textural fill values should be avoided. The use of colour will insure that the display is less busy, that form is easy to process, that form displays quickly, and that a more graphic, direct statement is made.

Positive and negative form
"Form is generally seen as occupying space, but it can also be seen as blank space surrounded by occupied space. When it is perceived as occupying space, we call it positive form. When it is perceived as blank space surrounded by occupied space, we call it 'negative form'."(Wong, 1972, p. 11). Not only do we see forms or objects (positive form), but sometimes we notice the shapes (negative form) around objects. Page creators should be careful that the shape which catches the viewer's eye is the one they are intended to see. Sometimes negative shapes are too prominent. Consider for example a solid dark blue arrow in a solid yellow circle. The bright yellow shape around the arrow would be prominent, rather than the darker blue arrow. A much more satisfactory solution would be to render the arrow in bright yellow and the background circle in the dark blue (assuming that the arrow is the important shape to be seen). The arrow would then be more conspicuous than the background.

Moving form - animation
Proper coverage of the subject of videotex animation would require a great deal of investigation beyond the scope of this project. Some general comments can however be made with regard to its use.

As with form in general, animation should be used when it serves some purpose. The use of animation is important because it can explain certain concepts involving time, sequence and causal relations more effectively than a static image can (Leith and O'Shea, 1980; Huggins and Entwisle, 1974; Mills, "Evaluating the impact of videotex images", 1982). Animation can explain flow, process or action. It should be used when it helps to explain.

Decorative animation or animation for the novelty value of animation (or blinking for that matter), uses valuable display time and can distract viewers from other more important information. Our visual system is designed so that it is extremely sensitive to movement (Arnheim, 1974; Haber and Wilkinson, 1982). Nonfunctional animation will likely only appeal to users whose motivation for viewing pages, is that they are seeking entertainment, (such as with children). Again it's value is questionable when users are paying for information.

Since animation is so distracting, it is recommended that viewers be allowed to initiate animation activity with a keypress (Merrill,1982). The user will then be prepared to concentrate on it at the appropriate time, will know what to expect and will not miss any of the action while viewing other information on the page. The chance to interact with the page and the content, adds to user stimulation and interest.

If animation is used, timing and presentation order should be carefully controlled. Movement should not be so fast that viewers can not follow the action. Forms will have to be simple so that they do not build too slowly (Morse, 1979). Wait commands can be used to control speed. Sequenced events should be in a logical order.

Form banks
As videotex pictures and animation sequences take time and effort to create, they should be stored for use in other applications. Certain pictograms are general enough for representing numerous topics (i.e., coffee cup, plant, head with light bulb). They can be collected in a form "bank" and edited into pages as needed.

Summary
Humans process, store and recall pictures more efficiently than text. Pictures should be used to reinforce content, attract attention, add interest, break up text, condense explanations, and improve reader's ratings of information. The videotex picture creation facility should be exploited to improve information delivery to users.

Rules should be used to divide, enclose, structure and organize information. Luminance value of rules should be kept low. Rules should fit the grid.

Page creators should be cautious that pictures created are understood by the target audience. Recognition and understanding of pictures depends on culture and experience.

Form should be used when it serves a function. Decorative form should be avoided. Form should impart information. Form should relate to content in a meaningful way.

Form should be kept simple and stylized. Page creators should avoid simulation of realistic detail. Images should have flat shapes, regularity, directness, should be reduced to essential information, and be geometrically based. Use of the sketch feature should be avoided unless images are traced and converted to polygons. Pictures should be neat, aesthetically pleasing and sophisticated in their presentation. Solid shapes should be used, not outlines or linear images, unless lines are very heavy.

Simple symbols and pictograms should be meaningful, have no unwanted meaning, should be constructed from geometric forms, should be solid shapes, should be closed shapes and should be recognizable. Verticals, horizontals and 45 degree angles should be used. Unnecessary detail should be eliminated.

Graphs should make one point only. Solid colour areas should be used. Line graphs are better for trends. Lines should be at least 2 pixels wide.

The illusion of depth can be created by overlapping, size change, colour change, view change, curving or bending, or use of shadow or converging lines. Depth and volume should be used to improve clarity and appearance.

The use of textural fill values should be avoided. page creators should make certain that positive shapes, not negative shapes are seen.

Animation should serve a purpose. Viewers should initiate animation with a keypress. Timing and presentation order should be carefully controlled.

Pictures should be stored in "form banks" for later use.

Medium unique aspects of form creation,
The videotex medium offers great capacity for picture creation. Unlike print, (where the cost of adding colour pictures can be expensive), words and pictures seem to be on an equal footing (Twyman, 1982). Space restrictions dictate that some concepts can be explained better with pictures than a lengthy text explanation.

The medium permits operators to see instant full colour pictures, and allows them to test or edit ideas on screen. They can view the finished product immediately without waiting for proofs or without changing artwork. Editing is easier than in other mediums. Colours can be changed, parts repositioned, or the whole picture can be moved with little effort. Automatic textured fill values can be invoked. Form, symbols, or pictograms can be stored at will and produced instantly for use in other applications.

Other technological features make form creation unique. Pictures are constructed from bright, regular, geometric shapes of low resolution. Images exhibit boldness and strength. Resolution, memory and display economics restrict use of detail or attempts at realism. Images must therefore be relatively simple. Formula stylization and exaggeration is required. Pictures must be created primarily from verticals, horizontals and 45 degree angles. Pictures must be more like pictograms. Pictures can however, readily appear crude and "simplistic" if executed in an amateurish fashion.

If more detailed pictures are created, they take a very long time to display. People who are paying for information may not want detailed, decorative or "pretty pictures".

Stylistic interpretation is limited. Print permits designers to establish a certain mood, through

the use of different text fonts and techniques of illustration: serif type and fine line illustration for example. The nature of videotex shape and colour gives all images the same, somewhat cold technological style.

The subtleties which can be produced in print cannot be created with videotex. Resolution limits use of contrast of form. Very fine lines are not available. Space can not be generously used to separate formal elements. Pictures must be very compact.

Movement and time become important factors. Animation is permitted, but it is not the same as film animation, and does not incur the expense of film. Movement can be exploited to show process, flow or growth. Movement can also be distracting. Presentation order strongly affects viewing order. Blinking is possible.

Viewers can interact with form. Pictures can be displayed, removed, replaced, or added to, all in the same frame, to make a point, with only a keypress.

Introduction
The basic principles of design may be described as the active forces at work on form in space, as perceived by the viewer. Wong (1972), defines these principles as the rules or "grammar" of visual organization. They control figure/ground relationships, where attention is focused, visual balance, relationships between forms (connected, separate, larger, smaller), whether an image is active or static, and so on. Some of these design principles have already been touched on. They affect many areas of the visual communication process. Note that the design principles affect text, colour, and overall page layout as well as form.

Many of these design principles are based on visual perception research, and some come from experience of designers and artists practised at the craft of organizing form. These principles are accepted fundamentals in the field of art and design and have been well documented (Wong, 1972; Arnheim, 1974; Bowman, 1968; Cheatham, 1983; Dondis, 1973).

The point made earlier with regards to single element testing warrants reiteration now. Laboratory testing of single design elements is difficult because forms interact with one another. This phenomenon has been noted, explained and studied by the gestalt psychologists:

> The German word Gestalt is not readily translated but roughly it means 'form' or 'configuration'. The Gestalt psychologists noticed that many perceptions exhibit the active grouping of elements together... and from this realization they developed their favourite saying: *'The perceptual whole is more than the sum of its parts'*. That is, parts are not treated as separate and isolated entities in perception. Rather, parts interact to produce a *Gestalt* which can differ markedly from what would be if expected parts did not affect one another.(Frisby, 1980, pp. 111-112).

The design principles define some of the relationships that take place between elements in a given space, lending predictability, to the Gestalt "interaction".

Although these principles have traditionally been applied to the print medium, there seems to be little difference when they are applied to controlling formal relationships in videotex. Two new principles may however be identified as being specific to videotex: actual time and motion, and for lack of a better term, the "invisible dimension". Although it is possible to create illusory time in print through sequence, growth or transition for instance, videotex permits a real time factor in animation (as with film) display presentation order and user interaction with information (unique to videotex). The addition of new form, through the unfolding of information in a controlled time frame, can alter the relationships of form already present on the page. The user can actually affect formal relationships with a keypress.

The "invisible dimension" refers to the context within which the unit page image sits. This context, that is the other pages of information, can not be seen but must be envisioned and remembered as it is encountered. Users can not flip through the pages for a visual summary or overview of the contents, as an aid to understanding visual relationships across the series. How to deal with this unusual principle will be discussed in the section on "Synthesis".

The basic principles of design should be reviewed whenever a page is created. Page creators should be aware of page dynamics *before* they affect the user, and should make an effort to control them to the advantage of the information provider and the user.

These principles are best described visually. This section will simply provide a short written description of the principles. Readers are advised to consult the course software for visual illustrations and applications of these principles.

Balance
Balance is one of the most important design principles. Arnheim (1974), compares visual balance to the balancing of physical bodies or objects in our everyday environment. Two forces pull in opposite directions or, there exists a fulcrum or centre of gravity for objects. "It would follow that the eye experiences balance

when the physiological forces in the cortical field [the brain] are distributed in such a way that they compensate each other.... Balance is the state of distribution in which everything has come to a standstill." (pp. 9-12).

If a picture or a page is not visually balanced, it will appear to be unstable. Viewers will be distracted by a heavily "weighted" area or will feel that the entire image is tipping. The state of rest or "standstill" we seek, comes not from measured placement of identical shapes in exact opposite poles or positions, but rather from a sensitive distribution of weight and colour within the picture or page space.

Balance can be affected by many things. Certain elements will carry more weight than others. Larger elements are of course heavier. As light (high luminance) objects are more conspicuous, light coloured objects can have more weight. Objects which are isolated with space will be heavier. Three large solid squares clustered together for instance, can be balanced by one small solid square which stands off isolated, by itself in space. Direction, that is where vision is directed, can also affect balance.

Colour distribution is important. If one side of a picture contains a lot of one colour, say yellow, as compared to the other side which contains greens and blues, it will appear unbalanced.

Page creators should insure that pictures and pages are visually balanced so as to avoid unwanted distraction and instability. Images should appear to rest comfortably in their space.

Size and scale

Consider again, the fact that forms continually interact with one another. This interaction can cause the size of shapes to appear to alter, even though their size has not changed. One of the "Luckiesh illusions" presents 2 circles of equal size, one surrounded by small circles and one surrounded by large circles. The original circles of equal size clearly appear to be different sizes. The circle surrounded by small forms appears larger than the circle surrounded by large forms (Rosenfeld and Kak, 1976). This shows that the size of elements in a picture may not *appear* to be the desired size, when other forms are near. It may be necessary to exaggerate or reduce the size of elements to compensate for size illusions.

One other point may be made about size and scale. Objects which are large will seem closer, while objects which are small will seem farther away. A large tree and a small tree presented in the same display may appear respectively, close to the viewer, and far off in the distance from the viewer. This visual "cue" can be used to simulate depth and distance.

Symmetry and asymmetry

A composition is symmetrical when all parts of the image are equally dispersed around or divided by a central axis. This equal balance on a central axis represents a state of true equilibrium. Conversely, in an asymmetrical composition, parts are positioned in such a way that they cannot be equally divided by, or arranged around, a central axis (Cheatham et al., 1983). True symmetry presents exactly equal elements, balanced in identical, opposite positions about a central axis. A single, large window flanked by two smaller windows, each in exactly the same position on either side of the large window, would represent symmetry. One sees symmetry used frequently in architecture. Asymmetrical compositions are random or irregular arrangements of varying elements in a space. This does not mean that they are unbalanced, only that balance is maintained through the manipulation of different elements in varying positions. A large window on the left of a wall, with two smaller windows to the right of the large window, would represent an asymmetrical arrangement.

Symmetrical arrangements tend to be formal, stable and static, as well as easy to decipher (perhaps to the point of being boring). Asymmetrical arrangements are more informal and active. A certain amount of visual tension in the way symmetrical pictures are balanced, creates interest. Asymmetrical compositions tend to be more interesting than symmetrical compositons.

Proximity
The Gestalt "organizational laws" define groupings which are most likely to be perceived as units. The *law of proximity* states that elements which are close to each other will tend to form groups (Rosenfeld and Kak, 1976). On the other hand, elements which are separated by space, will become isolated. This has implications for page and picture creation. If elements are close on a page they will become one "chunk" or group, and will be seen to be related. Usually, this grouping can diminish the quantity of perceived elements in a space, thereby reducing the processing load and clutter. A composition may be seen as being made up of only three units, while in actual fact, there may be three *groups* of two or three elements each.

Forms which are in close proximity can be spatially detached or can touch, overlap, penetrate, unite, subtract (the form underneath disappears), intersect or coincide (completely overlay) (Wong, 1972). These proximity interrelationships offer a number of options for organizing forms.

Similarity
Another Gestalt law of organization states that similar elements will tend to group together (Rosenfeld and Kak, 1976; Arnheim, 1974). Elements can be linked by similar size, shape, colour, direction, value, or speed. Colour coding is an example of how similar items relate.

Similarity groupings can be used to clarify visual relationships. Consider for example a row of identical green figures with the exception of three, which are yellow with blue symbols where the human heart would be. The caption would read: "Three persons in ten develop heart disease." Similarity shows us that the green figures belong to one set or group while the yellow belong to another.

Contrast
Contrast of colour and luminance have already been discussed. It was pointed out that with respect to detectability of an object, the primary factor is the difference between an object and its surround. This applies not only to colour value, but also to other visual attributes such as movement, shape, size, texture, position, direction or volume. Contrast in any one of these respects can create high conspicuity and emphasis.

More important, as Cheatham (1983) argues: "The differences created by contrast can make a visual statement more dramatic and exciting. The more striking and emphatic the visual differences are, the more engaging and interesting the overall expression can be." (p.89). Contrast in form can make pictures more dynamic. An arrangement of elements is much more interesting if the elements vary in size or colour than if they all appear similar and create a regular monotonous pattern.

In addition, strong contrasts prevent ambiguity. Research shows that in a memory test of simple ambiguous drawings, subjects either exaggerate or delete the ambiguity to produce an image that is clearly unambiguous. This is because it makes the viewing task simpler (Arnheim, 1974). With respect to form creation on videotex, an element which is *clearly* larger or smaller, or angled or straight, will be easier to process than a weak stimulus, that leaves uncertainty about whether the element is actually larger or crooked, or if it is a mistake. If a diagonal line is used it should be on a sharp angle rather than a few degrees off horizontal so it is clearly angled. Form contrasts should be strong enough that there is no doubt about the "difference", whether it is one of size, movement or direction.

Direction
Direction is simply the orientation of an object or objects in a spatial frame. Direction is important because it can control scan paths of the eye. It can be used to lead a viewer to information. A figure for instance with an outstretched arm becomes, through the line created by the arm, a directional device to lead us to say, a title. The example in the course shows a person with suitcases, waving goodbye. Above the figure's arm is a sign which reads "Departures". The figure communicates the message visually, and guides attention to the verbal clarification through the use of direction. Direction should be used to control where the viewer looks on the screen.

Linear elements or repeated forms are particularly directional. Diagonally directed forms tend to be dynamic and active while horizontally and vertically directed forms are static and passive.

Animation can also be used to actually move the viewer in a specific direction on the screen. Direction can also control weight and/or balance.

Repetition
Repetition of simple unit forms can create movement, activity and direction. The use of repeated regular shapes promotes harmony, unity, and rhythm. Repetition can be seen in the rows of windows in architecture or in the designs inscribed on ancient pottery.

Repetition may be thought of as a device for designing pictures. Page creators can repeat shape, size, colour, direction, or position. Repeated forms can be arranged linearily, or in squares, circles or other geometric configurations. Repeated forms can vary in direction or spatial arrangement, and can also be reflected or rotated (Wong, 1972).

Repetition of simple forms might be used to construct a sea wave pattern on a bulls' eye or even a honeycomb pattern to signify a topic on beekeeping. The copy and move functions make the manipulation of repeated images simple.

Harmony
Harmony is one of the most abstract design principles and is therefore difficult to define, and to provide a formula for achieving. **Websters new world dictionary** (1970, p. 638), defines harmony as: "1. a combination of parts into a pleasing or orderly whole; congruity 2. agreement in feeling, action ideas, interests etc.; peaceable or friendly relations 3. a state of agreement or proportionate arrangement of color, size, shape etc...." Harmony with respect to page creation may be described then, as a state where all page elements (text, colour and form), work together in an agreeable, comfortable, pleasing fashion.

There is no formula for creating harmony, but generally one might say harmony is achieved when page elements and design principles are correctly manipulated, in an organized, rhythmic, unified manner. Harmony should come about naturally if pages are carefully designed with all the visual communication fundamentals considered. Nevertheless, page creators should *seek* harmony within and across pages, checking to see that elements are compatible, consistent, and pleasing to view and read. Viewers should be neither disturbed nor bored, and should feel a sense of order and unanimity. This harmony will promote legibility and comprehension. Pages which are not harmonious may be disruptive, confusing and unstable.

Anomaly
Anomaly simply means an irregularity or variation in a regular design. A field of green squares containing one yellow square is an anomalous situation. Anomaly, like contrast, may be related to Roufs and Bouma's (1980) discussion of conspicuity, which you recall states that detectability relates to the difference between an object and its background. In this case the background is any regular state, and the conspicuous element is the anomalous one. Anomaly is therefore an effective method of attracting attention. An example is given in the course. Two pictograms are presented for a page on home maintenance. The first pictogram, entitled "Pipe breaks" shows a row of regular, neat metal pipes, and the last one is broken in half. Anomaly draws attention to the broken pipe and makes a visual statement. In the second pictogram entitled "Tools needed", a row of tools are presented. Tools not required are green. The tool which is required (a wrench) is anomalous in two respects. It is a different colour (yellow) and it is in a different position (raised above the other tools). Elements can be anomalous in colour, position, direction, shape, size, or speed.

Anomaly is also very important as a device for relieving monotony. A field of green squares is monotonous. If a yellow square is inserted and tipped on a diagonal, the arrangement becomes more interesting. If videotex pages were all text they would be monotonous. Pictures help to interrupt that monotony. Pictures can be a form of anomaly.

Anomaly and contrast are similar. The difference is that anomaly relates to an interruption in an overall discipline or state of regularity (Wong, 1972). Contrast can exist under any conditions.

Concentration
Concentration refers to how concentrated multiple forms are in a space. Forms can cluster together in one area, like a crowd around a demonstration, or forms can be dispersed like cattle spotted over a field. Concentration refers to how close or far apart a number of forms are.

Concentration is another way to create emphasis and direct attention. Forms which are tightly clustered in one area will draw attention. A gradual transition from loosely dispersed forms to tightly concentrated forms can create a visual path from one area to another. Concentration usually involves repetition. It can also be used as a method of constructing pictures.

It differs from proximity (which relates to items being seen as groups as opposed to isolated units), in that it usually relates to the spatial distribution of a number of forms, and especially to a change in quantity and/or dispersion of forms.

Gradation and radiation
Gradation is a gradual transition or transformation of forms, that takes place in orderly steps, such as large to small, many to few, or fast to slow (Wong, 1972). A logarithmic scale is a good example of gradation. The progressive stages of the sun rising up from the horizon if framed in steps, would be a gradated sequence.

Radiation is gradation which "radiates" from a central point. The bull's eye or the spiralling snail's shell are examples of radiation.

Gradation and radiation usually, have some sort of systematic structure, involve direction, and are created with repeated forms. As such, they are effective constructions for showing movement, change and especially, energy. Gradation and radiation can be used to organize form, construct patterns and structure transition or progression. Repeated, radiating shapes could for instance, be used to construct a windmill for a topic on energy alternatives. Or, gradated stripes could be positioned behind an object to suggest speed and movement in a specific direction.

Movement
Movement can be used to attract attention, direct the viewing path, or show growth, change, or process. Movement may be divided into two types:

1. Actual motion
2. Illusory motion

Actual motion refers to actual physical movement of objects on the screen, and to the visible activity created by the unfolding of elements as they display in a page (display or presentation order). An animation sequence of a ball bouncing would be an example of actual motion. The additive nature of the display "buildup" of a diagram is also perceived as actual motion.

This buildup may in fact be controlled by the user to clarify sequential information. This would be a form of "interrupted movement." Parts of a drawing could be presented "piecemeal" each time the viewer requests new information (Mills, "Evaluating the impact of videotex images", 1982). For example, a diagram of the human eye could be displayed. A keypress would cause the picture to be added to, showing perhaps the retina with a textual explanation. Another keypress would retrieve the fovea and focusing mechanisms of the eye. The sequence could continue until the diagram is complete. The viewer not only sees the whole develop, but has a better understanding of the parts and how they relate. The viewer also ingests information at his/her own pace.

Illusory motion, on the other hand, refers to the illusion of movement created by controlled viewing path. We witness this in paintings, where a gaze or a line, moves our eyes around the picture to specific areas. In videotex, once display activity stops, static objects can cause the eyes to move from one place to another according to how the forms are arranged.

Illusory motion usually involves repetition or direction or sequence. A long arrow will cause eye movement from one place to another. A gradated sequential presentation of stages of plant growth arranged step by step, left to right, will result in a viewing path which moves left to right, over the images.

Page creators should be conscious of the principle of movement and should inspect pages to see where attention is moved. Movement should not distract or misdirect viewers. It should be used when it serves a purpose. The subject of actual motion is a larger topic which must be dealt with separately, in conjunction with animation. This is a topic for future research.

Time and speed
With movement, comes time and speed. Motion is only possible when some sort of time frame is involved. It is possible to control the time and speed of movement, to make information presentation clearer, more dramatic or more realistic. As with movement, there are two kinds of time:

1. Actual time
2. Illusory time

Actual time is a factor in actual movement. The presentation or activity takes place in an actual time frame. This time period can be short, long or somewhere in between. Speed is also then a factor. Action can be fast or slow. The speed at which an object moves or an event occurs, and the time it takes for an activity to occur should relate to the subject matter and purpose. If a plumbing repair is being illustrated, activity must be slow enough that the viewer can see what is being done. If an example of a car, parallel parking is presented, action speed should be similar to the actual event. Elements can be made to "fuse", (as they do in animation) by using many steps, but creating this type of animation is a labourious process, and must be warranted by the function which the animation will serve.

Illusory time occurs with illusory movement. The speed with which a viewer scans a sequence or element or series of elements, depends on other principles. Speed will be determined by the number of steps in the change or series, by the type of forms selected, and by their direction. Larger objects seem to move more slowly than smaller objects (Arnheim, 1974). A series with many steps shows higher speed than one with only a few steps. Forms which meander horizontally across a space will be perceived as moving slower than forms which plummet downwards, on a sharp diagonal. Linear or arrow shaped objects will be scanned more quickly than clumsy blocks.

Time and speed can be manipulated to impart a feeling of directness and strength (fast) or perhaps calm, wandering relaxation (slow). It should be remembered however, that time and speed must be appropriate to the subject.

Summary
When designing pages, page creators should review the basic design principles. They should think carefully about what will happen visually when a viewer sees a page. The design principles should be used to assist in communicating information more clearly, in directing viewer attention, and in controlling how form interacts.

Pages should be visually balanced. A state of equilibrium should be prevalent.

Compensations should be made with respect to size change created by formal interaction. Forms which are to be perceived as close should be large, and those to be perceived as far away, should be small.

Pictures which are symmetrical will be stable and static. Asymmetrical images will be informal and active.

Elements to be seen as a unit should have close proximity. Elements to be seen as isolated items, should be separated with space. Elements should be "chunked" to reduce the processing load.

Similarity groupings should be utilized to clarify visual relationships.

Contrast can be used to create emphasis, to add

interest, and to prevent ambiguity. Page creators should use contrast in movement, shape, size, texture, position, direction and volume.

Direction should be carefully controlled. Viewers should be led to important information. Distracting direction should be avoided.

Repetition should be utilized as a method of creating images, and of imparting movement, activity and direction. Shape, size, colour, direction or position may be repeated.

Page creators should seek page harmony within and across pages. Pages which are not harmonious will be disruptive.

Anomaly should be used to create emphasis and relieve monotony.

Concentration, gradation and radiation should be used to construct images, and to direct attention to a specific area.

Movement should be used to attract attention, direct viewing path, and show growth, change or process. Actual movement and display buildup should be used to present information more clearly.

Page creators should be aware of scanning activity created by static elements. Illusory motion should be manipulated to direct the viewer.

Time and speed of both actual and illusory motion should be carefully controlled. Time and speed should be appropriate to the subject matter and purpose.

Medium unique aspects of the design principles
Design principles unique to videotex are actual time and motion and the "invisible dimension". Although actual time and motion are possible with film animation, unfolding of page information and the ability of users to control and interact with page information is unique (although these features may exist in other computer systems). The fact that formal relationships in a page can be altered with the presentation of new or additional material on the same page, is an important new principle. The user has a role in affecting the layout of a page. The time/motion factors interact with the other design principles. The principle of contextual relationships across a page series, where only one set of information is available for viewing at a time, is also important, and is dealt with in the section on "Synthesis".

Visual balance of a page can undergo a progression of changes before the page is completely displayed. Likewise page balance can alter if the page is changed with a keypress: that is if information is added or manipulated. Animation can also dramatically affect balance. A moving form may change weight from left to right and then vanish. Animated objects will carry more weight due to their conspicuity.

With respect to size and scale, system resolution dictates that forms may have to be exaggerated in size. Realistic proportions may not be feasible within the restricted spatial frame.

Space restrictions also dictate that forms must be "chunked" or grouped in close proximity, to avoid clutter. Motion can alter the spatial relationship between forms.

In addition to normal similarity groupings, by shape, size, colour, and luminance, elements may be similar with respect to time and speed.

Color contrast can be excessive due to the nature of electronic colour. Colour contrast is very important, because the colours tend to be of similar brightness (unless saturation and luminance are altered). New contrasts are available; luminance contrast, time and speed contrast and the contrast of a static object and a moving object.

Actual motion can create extremely strong direction. Viewers can be "moved" to specific information.

Repetition can be used to create animation. Actual time and speed of repeated forms may be controlled. Repeated forms can be made to appear, disappear and reappear. Information can be blinked. The copy function makes generation of repeated forms very easy.

Page harmony is more difficult to achieve with videotex than with other mediums. Electronic colour, screen resolution, and page buildup can cause disruption. Pages tend to be garish and busy.

Anomaly can be achieved through variation of time and/or speed. A blinking element could be the anomalous feature.

Concentration of forms could change, according to page buildup, or with erasing and replacing of forms. Forms which are close could physically be seen to disperse or become less concentrated.

A gradated transition could be fused into an animation sequence showing growth or change. Gradation or radiation could erase and repeat, to actually "pulse".

Actual motion, and its affect on the other principles has been discussed. Any change in the screen display will affect existing page elements. Movement becomes an extremely effective device for explaining, or clarifying certain types of information and for attracting and directing attention, but motion can also be very distracting.

Timing and speed of motion become very important principles. The viewer can also control the speed and timing of information presentation, viewing or working at their own pace.

Introduction

Synthesis is defined in **Webster's New World Dictionary**, (1970), as "the putting together of parts or elements so as to form a whole."(p.1445). With respect to videotex, we are concerned with how to combine the elements or "tools" defined (text, colour, form and the design principles), into organized meaningful pages and/or page series. "A display is more than just a collection of static elements; it must use aggregated elements to support a dynamic user/display interaction..."(Knapp et al., 1982, p. 196). How can these component parts be logically, clearly and systematically synthesized to ensure that information is effectively communicated to viewers? This section presents some guidelines for formatting pages. Many aspects of synthesis have already been discussed in the other sections. It is impossible to detach the "tools" for page creation from the larger whole or finished product. The end page layout and page structure must be considered when discussing the aggregate parts.

It is clear that any organizational principles presented, must be appropriate to the videotex medium specifically. Certain unique considerations exist for videotex page layout and organization; the space restriction, the landscape format, the motion and time factors, user participation with information and contextual relationships within a database. Unfortunately, there is a tendency for page creators to format videotex pages like book pages, forgetting that the rest of the book is not immediately available for viewing (Bork et al., 1983).

Parallel to these considerations for data synthesis, lies the essential regard for the user and his or her problems. Again everything possible must be done to facilitate the delivery and exchange of information.

One can approach the problem of page format and structure by examining existing faults in page organization. Two major errors prevail in this respect:

1. Pages are too cluttered
2. Pages tend to be designed as isolated entities with no relationship to other pages.

Page creators invariably try to cram as much information as possible into a page. Pages which are cluttered and difficult to decipher may *increase* viewing and connect time (Whelan, 1982). Viewers may also react negatively to the confusion, and avoid using the system altogether.

Observation of videotex database material reveals that pages are treated, and hence designed, as isolated entities. There seems to be no visual link or clear interrelationship between pages, even in those which are part of a series. Pages usually *must* have some relationship even if only by company. Also, it would be impossible to index and structure multiple topics which are unrelated (Whelan, 1982). This lack of visual and structural continuity is a cause for concern.

This all brings us to the fact that synthetical organization must take place on two levels:

1. In single pages
2. Throughout multiple pages or a page series.

Each of these levels has its own "challenges", but it must be kept in mind that the single page is still always connected to its context- that of the other pages.

Some general concerns may be identified for each level. Within individual pages, page creators must address the overall page, "gestalt", complexity, display time and order, use of blank space, the design principles, meaningful chunking, viewer stimulation, viewer interaction with that page, elemental hierarchy, unity, a system for arranging elements, and the use and positioning of items relating to the other pages.

Throughout multiple pages or a page series, the page creator must address the problem of invisible information and hence visual linking, consistency and unity. As well, structuring of multiple pages or a database encompasses viewer interaction with the series, unfamiliarity (on the part of the user) with database search, person-machine dialogue, database software variations, the sequential narrative, index design and any associated costs.

Message communication
"Communication is the production, transmission, and consumption of messages..."(Doblin, 1980, p. 89). For each new page or page series created, the page creator must control identification, creation, delivery and absorption of visual messages. So, communication of information requires a message *and* a sender and a receiver. The message is "coded" by the sender and "decoded" by the user. The coding procedure must be understood by both parties. If it is not, an intermediary (the page creator) translates the message to a form which can be understood by the receiver (Johnson, 1982).

The control or translation of messages relates back to the planning process. Recall the importance attributed to identifying problems and defining objectives. The page creator, in cooperation with the originator, and considering the individual audience, must clearly identify the messages to be communicated to the user. Once messages and themes have been established, the page creator then faces the problem of message "production, transmission, and consumption," in the overall page design.

What then are the requirements for effective, efficient production, transmission and consumption of messages? Doblin (1980) provides a comprehensive model identifying twelve criteria for visual messages:

1. Message must reach decoders.
2. Message must be powerful.
3. Message must have sufficient time [to be decoded].
4. Message must be perceptible.
5. Message must be decodable. The message must use language that can be decoded.
6. Message must have proper hierarchy.
7. Message must have decoder prepared. Decoders must be given the meaning of the symbols used before a message can be delivered successfully.
8. Message must have integrity.
9. Message must be properly crafted.
10. Message must be credible.
11. Message must have congruity.
12. Message must be exciting.(p. 100-105).

Doblin also breaks the list down into three "clusters" of statements which may be identified; transmission accuracy, precision of the transmitted meaning, and effectiveness of meaning on conduct. This list provides an important guide to message requirements. The list should be reviewed when pages are created. Readers should consult Doblin for a more detailed description of the message "musts".

Planning, text, colour, form, the design principles and careful organization within and across pages, become the tools for insuring that messages are communicated in an efficacious manner. Many aspects of manipulating these devices to facilitate and enhance message communication have been discussed. These principles can be applied to the overall layout of a page. For example, if the message identified is one of seriousness, and orderly professionalism, say for a topic on legal concerns, colours should be cool and neutral, text should be neat, elements should be formally organized, images should clarify content and should not be playful. Symbols and terminology should be understood by the user, instructions and reference material should be clearly and consistently coded. Space, colour and headings should prioritize information, and so on. A very different message may be required to introduce a less serious topic on "New Music" to teenagers. The message might be one of playfulness, post modernity, and lyricism, in order to attract and retain this group's interest. "Trendy" colours may be appropriate. Elements could be rendered and organized in a contemporary, playful and expressive fashion (bars, lines, drop shadows and musical forms creating visual texture, meaning and emphasis). Text could be dramatic (large letters, or changing letter size). More freedom could be exercised in text arrangement. Note, that these "playful" elements should still perform functions and should still relate visually to the content and structure of this and other pages. Playfulness does not imply artistic license, only meaningful appropriateness to a particular subject. The needs and interests of the audience not only for entertainment but for understanding, are of primary importance. The page creator must be certain information is easy to read and find.

Page creators should clearly identify messages, themes, and ideas to be communicated, and should use all available techniques to facilitate effective production, transmission and absorption of these informative messages. All aspects of a completed page and/or page series should be analyzed to this effect.

Viewing hierarchies

In any given page or page series, some information is more important than other, or must be viewed in a specific predetermined order. Page creators should define the viewing hierarchy for information, and then organize the page or page series in such a way that the user's scan or selection path is stringently controlled. This prioritized or hierarchical structure, may encompass headings, subheadings, important illustrations, crucial instructions or information which must be understood before proceeding to other information. This viewing hierarchy must be considered on four levels:

1. In a static page.
2. In an animated page.
3. In page display order.
4. Throughout a database or page series.

Within the static page, that is the page where there is no actual movement, and display activity has ceased, hierarchical structuring is largely a question of visual emphasis. Certain elements in the display must be emphasized to attract attention first. Recall from the sections on text, and colour, that emphasis can be created by colour change, brightness contrast (especially light colours against a dark background), isolation with space or rules, chunking, or text size or weight change. Recall also that attracting attention, relates to conspicuity, which was attributed to the difference between an object and its surround. When we search a display for information, we make random eye saccades until a conspicuous object is detected in eccentric or parafoveal vision and then fixated on (Roufs and Bouma, 1980). The page creator must therefore emphasize the desired elements so that they are more conspicuous. Engel (1980) found that our eyes will involuntarily fixate on conspicuous items whether or not they are search targets. This means that any information which is conspicuous will be fixated on, and that if that information has little or only secondary importance, that *unwanted* emphasis will be created. Viewers can be distracted by conspicuous elements which are unimportant. Care should be taken that emphasis or conspicuity is controlled.

Aside from the previously mentioned methods of emphasis, there are other ways of making information conspicuous. Recall the design principles. Emphasis can be created by; size changes- larger objects will attract attention, proximity- isolated items will attract attention, contrast of colour, luminance, position, size, direction etc. will attract attention, direction can lead the eyes to a certain area, repetition of forms can create direction and movement to a specific area, an anomolous element will be conspicuous, the eyes will be directed to an area of heavy concentration, gradation and radiation can create direction, illusory movement can create a viewing path, and finally, illusory time (such as sequence breaks or speed changes) can create emphasis.

Within the animated page, movement is the obvious appeal to attention. As mentioned earlier, our visual systems are extremely sensitive to movement. Any movement on a display, (especially fast movement) will be conspicuous. Whether the emphasized elements in the static part of the page take precedence over the movement, will depend on timing. If the animation is delayed, other conspicuous elements will be fixated on. If the animation occurs immediately, *it* will be fixated on. It will also be *very* distracting, and may create visual competition if it carries on while the viewer attempts to extract other information from the page. "Care must be used to avoid requiring the user to read a textual description and watch an animated display simultaneously. The text should be displayed first; then, when the user has finished reading the text, he or she can press a key to signal readiness to attend to the animation. In some applications, it may be more appropriate to display the animation first and then display the text. In either case, the user should not be expected to attend to two things at once." (Merrill, 1982, p. 404). It is

recommended that users inititate the animation with a keypress, so they are prepared to concentrate on it.

The design principles mentioned also apply to creating emphasis in the animated page. In relation to movement; contrast, direction, anomaly, gradation and radiation, speed and timing can be manipulated to create emphasis.

Viewing hierarchy can also be controlled by page display order. Page display order will in fact determine the first items viewed and will therefore *take precedence* over other emphatic variables. However, unless timing of the "unfolding" is controlled it is unlikely that the viewer will keep pace with the information presentation. They will likely begin reading something while the rest of the page develops. It is in fact advisable to give the viewer text to read while pictures develop so they do not become bored with the slow page buildup, as they wait for information (Hum, 1982). When they finish reading, (after display activity has stopped), the static page hierarchy will come into effect. Interruption of the display, as discussed in the section on form, is useful for focusing attention on a particular piece of information. The user then becomes an active participant in the information hierarchy, initiating each level with a keypress.

Finally, page creators must create a logical hierarchy within a page series or database. Pages must be organized in a manner which will guide the user to appropriate levels of importance in the correct sequence. Clear instructions and indexes will be critical to "navigating" this hierarchy. These topics will be discussed further in the sections on "Organizing page series", "Database structure" and "Viewer interaction".

With so many alternatives for creating emphasis, the potential for visual "chaos" is great. Overemphasis and multiple levels in a viewing hierarchy will create confusion and distraction, and will undermine page emphasis and hierarchical order. As with coding, the processing load will be reduced if the number of elements emphasized, or the number of levels in the hierarchy is kept to a minimum. Some elements can be grouped into one level.

Page creators should exercise careful control over what information is viewed, in what order, when a page displays. Viewing hierarchy should be clarified before the page is designed. Care should be taken that unintended emphasis, which may interrupt the viewing hierarchy, is avoided.

The "invisible dimension"

The digital storage of data, to the naive computer user, is basically a mystery. Although the videotex storage facility responds to users' requests, the information the user is seeking, appears to exist "invisibly" in some other dimension, elusively referred to as the "database". Jackson (1979) points out that when we read a book or newspaper, we know exactly where we are, and what other information is available. Unlike the videotex page, we can easily *see* the relationship between what we are reading at the moment, and the other parts of the volume. Furthermore, videotex pages display slowly, preventing us from "flicking" through them as we would in a book to overview the contents. Williamson (1981) suggests that print context relationships are more easily retained and understood than those of videoscreen displays.

In addition to the inability to see and understand the context within which an individual page sits (within a related page series) the nature and quantity of forthcoming information is unknown. In fact, it is not known if there actually *is* more information. Even if there is more information, the viewer may be unable to find that material, or he/she may "think" they will be unable to locate it. Indexes may be of little assistance as they either do not provide sufficient detail, or the user may not be able to get back to them.

The invisible dimension, therefore creates a host of problems for videotex users, especially if page creators are negligent in their attention to these concerns. Evidence of this neglect appears particularly in related page series. Unfortunately, these pages often look as if they have no relationship whatsoever, appearing rather like an assemblage of isolated entities,

with no apparent common source or connection. Clear instructions for moving through pages, are often also poorly attended to.

Dealing with the variable of unknown information requires considerable control over the organization, unity, consistency, routing instructions and indexing within single pages and across related pages, and in the database structure. Contextual separation necessitates the establishment of some sort of visual and structural link across pages, so they can be seen as part of a unit. Individual pages must orient and direct. Database structure must be carefully designed.

Organizing the single page

The page creator's first task when organizing single pages is to review the planning process. The user audience and their needs should be carefully identified and analyzed. The topic to be covered should be understood, and themes and messages related to that topic should be identified. Clear objectives should be defined. Storyboards should be developed with images, text and any other information specified. Page and text format, and a colour scheme, should be predefined. The originator's visual identity should be considered. Byte length should be a major concern when the page is designed.

As mentioned, one of the most prevalent problems with videotex page design is that pages are too cluttered. Although it would seem economical to put as much information as possible into each page unit, (as pages may incur a cost to the user) research shows that the more complex a display, and the larger the number of elements in that display, the more difficult it is to search, detect, extract and recall information presented (Knapp et al., 1982; Davis and Swezey, 1983; Cahill and Carter, 1976; Brown and Monk, 1975; Monk and Brown, 1975). Brown and Monk (1975) conducted tests of subject target search times under different nontarget background conditions, in a computer generated display and found that, "mean search times increased sigmoidally as a function of the number of nontargets in the surround. Search times were longer for unconstrained than for constrained [grouped] backgrounds." (p. 81). Later experiment by Monk and Brown (1975) clearly shows that dense target surround acts to camouflage the element the viewer is seeking. This camouflaging effect of dense displays is confirmed in Cahill and Carter's (1976) experiment on colour codes size.

The more congested, and cluttered a page is, the more difficult it will be for the user to extract information. Confusion and distraction should be eliminated at all costs. Pages *must* be kept simple. Any unnecessary information should be eliminated from the computer page (Reading, 1978; Reynolds, 1982; Davis and Swezey, 1983; Bork et al., 1983). This includes any irrelevant, decorative elements. Recall that unnecessary information may be involuntarily fixated on, causing distraction for the viewer.

Recall also that we have a limited capacity for information processing, as shown by Miller's (1956) research on short term memory capacity. Information which exceeds this capacity will put undue stress on the viewer in terms of their perceptual processing load (Simcox, 1983).

It is strongly recommended that page creators do not *fill* all the space in the page, and instead, that they use blank space liberally to break up the page (Merril, 1982; Bork et al, 1983; Whelan, 1982). Even when all text and images are displayed, some blank space should remain. To facilitate information delivery, it is better to add extra pages than to fill or cram a page with information. Recall also that information (both pictorial and textual), is easier to understand when it is meaningfully segmented and separated with space. Informational elements should be chunked to improve meaning and reduce the processing load.

Another reason for simplifying single page structure and content, is the fact that complex pages take too long to display. Users find long display time extremely annoying. Page creators should keep the number of page elements to a minimum.

In order to further simplify a page, the layout must be organized, ordered and neat. "Virtually every aspect of the study of human memory has

shown that organized or potentially organized material is perceived, retained, comprehended and retrieved better than comparable but unorganized material." (Haber and Wilkinson, 1982, p. 23). Positional alignment and structure of text and illustrations can reduce excess visual "noise". This desired sense of organization, order, alignment, consistency and unity can be maintained through the strict use of a grid system. Grids will be discussed shortly.

There are many other variables to be kept in mind when organizing the single page. Pages should have some relation to familiar, print format and presentation. Pages should be designed to incorporate future changes or updates. (The use of blank space and an organizational system will aid in this respect.) Illustrations which correspond to text should, whenever possible, fall on the same page. Each page should contain one compact unit idea. Page creators should assume an editorial function as the pages are input. Originators should be notified of necessity for this. Number of colours used should be kept to a minimum. Page creators should control direction, emphasis and viewing hierarchy. Careful attention should be paid to the order and timing of displaying elements. Movement should be carefully controlled. Effort should be expended to exploit the medium unique potential of videotex. Page creators should use animation, display development and timing to their advantage. Finally, page creators should insure the page stimulates and interests the viewer.

Generally, Morse's (1979) "Principle of Least Effort" is the key to individual page design. This principle dictates that a computerized information display should require the very minimum amount of effort necessary to view, perceive and interpret the presentation.

The next consideration in organizing the single page, is its relationship to accompanying pages or page series.

Connecting multiple pages

Inevitably, pages will not be designed as isolated units, but rather will have some relationship to other pages or groups of pages in a database (although, this consideration is unfortunately not always made). This relationship may be one of subject matter, or of company or organization. There may be a series of pages, all on the topic of travel destinations, or teaching first aid, or simply defining an organization's services. Nevertheless, pages will usually be related in some way, or another. As the viewer only ever sees one page at a time, he or she must be given some clue that related pages are in fact connected, or are part of a larger whole. This is important in terms of helping the user to know where they are, what topic they are on and when information is changing. It is not sufficient to design each page individually ignoring the rest of the pages. Current videotex databases tend to be page based (McFarland, 1982). This gives the reader little sense of context, unity and orientation. Unity must be imposed.

Related pages must be visually connected. The visual connection can be made through a consistent structure and colour scheme. Recall the Gestalt principle that similar elements will form related groups. The grid will provide a format which will lend a structural link to pages. Pages which have the same colour scheme will also be seen to be related. A format and colour scheme should be defined for related pages before they are created.

Consistency is critical, not only to connecting pages and creating unity, but to helping the user to know what to expect. Colour, structure, coding, positioning, language, use of space, system response and instructions should be treated consistently in all pages. Codes, orienting devices and instructions should be assigned specific positions on the page "so that users can develop spatial expectancies." (Tullis, 1981, p. 550) Once a user has seen a colour code or instruction or title position used consistently, it is easier to immediately assign meaning to those codes in subsequent exposure. Users will immediately know where to look for information they are seeking (Nievergelt, 1980). Page creators should be consistent in the use, colour and placement of features which reoccur on multiple pages. Note that this type of standardization is economical. Consistent

treatment provides a formula for page design. A new design is not required for every page.

Each page designed must orient and direct. McFarland (1982) points out that every page should perform three functions. First it should identify itself, so the user knows that he/she has selected the correct page. Second, the page should give information. Third, it should contain index information as a guide to where to go next. He describes these functions as the three "I's": identify, inform and index. Assuming that the page provides information, the page must then orient the user and provide an instruction or choice of where to go. This answers the classic questions of: "Where am I? What can I do here? How did I get here? Where else can I go? How do I get there?" (Nievergelt, 1980, p.18). Each page should provide a clear identifier as to the topic, section and page number, (preferably at the page top for easy checking as the page displays), as well as an instruction as to what to do and/or where to go next. Instructions should be short, simple, clear and consistent (Shneiderman, 1979). These devices should appear in the same colour and in the same place in every page. These orienting and directing devices will be most useful in establishing a sense of context in the "invisible dimension".

It is also important that multiple, related pages demonstrate a logical narrative flow (Marcus, 1980). Although pages are separate units, the conceptual flow should be evident in the content. Each page thought or topic should flow smoothly into the next, and the order should make sense. Maintaining a good narrative flow through connected pages, requires once again, an overview of the entire package, by both originator and page creator.

It is important to point out that connecting multiple pages does not mean creating an "epic" series on one point. It has been clearly shown that in a voluntary accessing situation, there is a distinct limit to the number of pages that users are inclined to view when those pages go on at length on one point, such as in a news story. They will only look at the first few pages. (Lane, 1980; Elton and Carey, 1983; Whelan, 1981). This seems to be especially true if the message runs on over multiple pages without variation in the search procedure (Lane, 1980). Recall however, that separate pages should act as separate modules for individual points. Nevertheless, the length of related page series should be kept short especially if the user is not motivated. This of course would not apply to required tasks such as instruction where the number of pages on one subject would be extensive, but where the user is obligated to, or very interested in, the task. Even in this situation, the page "idea unit" should still be retained. A related page series can however contain many pages, if there are many topics or separate points. The idea seems to be not to go on indefinitely on one point.

Recall also that complex logos should not be used on every page in a series to identify them as belonging to a set. A small text identifier is more economical in terms of display time. A viewer will only need to see a logo a few times before growing weary of waiting for it to display on each page. The pages can be visually connected in the other ways described above.

Margins

The single most important factor in connecting multiple pages, and indeed in organizing single pages is the grid system. Margins are always the beginning of a grid. Margins are very important for a number of reasons.

First of all, when viewing a computerized display, eye movements are concentrated largely in the inner half of the display. There are fewer fixations in the outer area of the screen (Monk, 1981). Important information which is located peripherally may be missed. As well CRT technology is such that resolution is best in the central area (Reading, 1978).

Also, home television sets have considerable overscan. This is to prevent a blank border from appearing around the picture. The SMPTE (Society for Motion Picture and Television Engineers), recommend that only 80% of the viewing area should be used in order to make certain information is seen (Treurniet and Hearty, 1981; ITTCC, 1979). However, since the SMPTE studies and recommendations

were made, television screens have become more rectangular in shape. It has been suggested that the 20% overscan constraint might now be relaxed somewhat to perhaps a 10% area (ITTCC, 1979).

Under the existing recommendations, if resolution is 256 x 200 pixels, with 20% margin area (10% vertical and 10% horizontal to make 20% overscan), margins would need to be about 25 pixels horizontally and 20 vertically. Split for each side of the screen, this would result in a space of about 13 pixels on left and right, and 10 pixels on top and bottom. To be safe, a minimum 15 pixel margin all around the screen is recommended for the 256 x 200 resolution. Note that television screen curvature may also warrant the use of margins.

Finally, margins give the page a sense of order. Margins will keep information contained in a neat, regular "block" without the noise or distraction of irregularily protruding elements. Margins will also help to separate the information from any surrounding clutter on the monitor or in the viewing environment.

Note that the top and bottom margins may be affected by the number of lines of text which will fit in the space. This will depend on page layout (i.e., whether page numbers, rules etc. will take up space on the page). Page format and margins should be conceptualized at the same time. For the sake of visual balance, the bottom margin should be at least the size of the side margins or larger.

The grid

A grid is simply a structure of invisible lines which provide a positional guide for all page information. It defines where titles, subtitles, page numbers, references, section identifiers, rules, running text and pictorial information will be placed. It determines margins, column divisions, and allotment of blank space. "This invisible grid lies behind every frame. Sometimes it must be broken or ignored for special materials. Although it can be violated occasionally, it must work most of the time. If it doesn't, a new grid must be devised." (Marcus, "Designing the face of an interface", 1982, p. 24).

The grid is an extremely important organizational device. Within an individual page, and across related pages, it creates a sense of visual order, unity and consistency. It defines spatial and positional standards which will help the viewer to know what to expect and where to look. It also provides that important visual (structural) connection between pages.

The grid has traditionally been used as a device to aid in the organization of print information. It seems to be just as effective when used for electronically generated material and is likely *more* important for this type of information because of the lack of visible contextual reference that exists when an individual VDT page is displayed. There is in fact, agreement on the usefulness of the grid for both print and VDT presentation of information (Hurlburt, 1978; Johnson, 1982).

Grid construction begins with the definition of margins. Then, a text line length must be determined. This will decide column width and hence the number of columns required. Columns should be of equal width, based on a pixel count. A space not less than 8 pixels should be left between columns. Finally, positions for other page elements (instructions, page numbers etc.), should be defined. These should correspond to the columnar alignment system. Depending on the page creation system, the grid can be defined and used in two ways; it can be drawn on paper (scaled to match screen size), and positioned on a graphics tablet for reference, or it can be drawn on screen and stored as a grid file which will not display in the finished page. If the page creation system does not permit either of these options (that is, it does not have a tablet or a facility for storing a grid file), page creators can draw the grid on screen and make written note of primary x, y positional coordinates.

Grids can be of five types; one column, two column, three column, four column or five column. Various combinations of the columns can be used for text, images or title area. For instance, the course uses a three column grid, with one column on the left for titles and two columns on the right for text and images. other elements (rules, references etc.), all align with

these divisions. A five column grid could utilize two columns for titles and three for text and pictures. Many variations are possible. The grid should be flexible enough to accommodate all types of information to be used, such as graphs, pictograms and titles. Space should also be alloted as blank space.

It is advisable to be flexible in the use of the grid once it is defined. If every page is identical in format, pages will be monotonous. Page creators should place pictures in different areas within the grid structure, and vary picture size and position of blank space. However, text titles and spatially coded elements should *always* appear in the same position, so the viewer knows where to find them. Once a position has been defined for running text, both the starting point and the column width (line length) should remain constant.

The page creator may find it helpful to "box" pictorial elements. A neutral, solid box which fits the grid, can be used as a background for diagrams, pictograms or other illustrations. The use of a box to contain pictures will reinforce the visual alignment and sense of order in the page. If the background is *very* dark gray, the picture boxes could be dark gray. This would keep the "drawing" field neutral. If a coloured background is used, a slightly lighter shade of the same colour would be appropriate for the boxes. This may mean that an additional colour (that is a different luminance value of the background colour), may have to be added to the page. This is not to say that all form must be boxed, only that it is often a useful tool for imparting visual organization to the page. Free form drawings can also be worked into the grid system. If boxes are used, it is important that they align with page text. the box edge should line up with the character base line (base of an "o" as opposed to a "p") or the top of the "x height" (height of the "o" or "a" not the height of a "d" or "k"). This will also keep the page neat and orderly in its appearance. Distance between boxes should be consistent. For a detailed discussion of grid systems and their development, the reader should consult Hurlburt's **The Grid** (1978).

Note that the page creator should experiment, on screen, with different grid systems, in order to find one suitable for the type of information he/she is presenting.

Database structure and search

When it comes to organizing multiple pages into a logical structure, which is easily accessed and used by viewers, the page creator must have some appreciation of information search and retrieval in an electronic database. Although videotex database software will vary in its capabilities and limitations (as there is at present no application level standard), it will most likely use a simple tree structure. When pages are organized in the tree, users will select a topic of interest from an index page, by pressing the corresponding number, and will then be presented, in response to their request, with the chosen page. There will then be a series of pages related to that choice available for viewing. Once the user is into general document pages, they will normally be able to move forward or backward one page or return to the previous or main index. There will however, in a large database, be numerous trees with numerous pages of information. Navigation of this maze of information is often confusing, even for those who have used the system before.

Studies have shown that users consistently get lost and give up searching for information when using videotex databases (Dillon and Tombaugh, 1982; Sutherland, 1980; Whalen and Latremouille, 1981; McEwan, 1981). Dillon and Tombaugh (1982) claim that:

> A number of investigators, testing subjects who used menu selection from the hierarchical data base, have indicated that users have considerable difficulty in locating information on videotex data bases.... Using widely different data bases and retrieval methods, these studies consistently show that users access approximately twice as many pages as are optimally necessary in finding material. It is clearly difficult for users to decide where information will be located in the hierarchy. (p. 194).

These long searches are very irritating to users (Jackson, 1979). Martin Lane (1980), in fact compares the videotex tree structure to a mine shaft. From the top of the shaft (the index), users search down, down, branching further until they reach a dead end. Clearly there are problems with videotex database structure and search.

There are a couple of reasons for these problems. First, it is likely that most videotex users are unfamiliar with computers and in fact, have no desire to learn a complicated information searching procedure (Bown et al., 1980). Second, page creators are careless in database structuring and menu page design.

It is the page creator's responsibility to control database organization, search path, and dialogue between the system and the user. If a user can not find the information provided, all page creation work is wasted. Good database design is important to the communication of information, and must not be left to chance. The page creator must anticipate questions and problems and deal with them effectively. Users require assistance in finding an efficient search path.

Several authors on computer structure and storage of information, offer recommendations for database construction. Sutherland (1980) in particular, deals extensively with problems of viewdata database structure and search. He points out that users may wish to browse information, or they may be seeking only one specific piece of information. Provision must be made for doing both. The routing logic used in structuring pages, must also match the user's idea of what that logic is. Sutherland presents a detailed method of pre-testing this logic on potential users. Readers may wish to consult this. Users often lose track of where they are. They must be oriented and they must know how to get back to the previous index. The complexity of action involved to access information (i.e., number of keypresses) must be kept simple in keeping with the limits of short term memory. Sutherland also suggests that alternative indexes (hard copy, or key word) should be provided to assist users in their search, and to help them know in advance if the information they seek, actually exists in the database. Users should never be left at a dead end.

Nievergelt (1980) stresses the importance of imposing some sort of visible structure over a series of pages, so users have a sense of where they are. Here again page creators must anticipate the questions: "Where am I? What can I do here? How did I get here? Where else can I go? How do I get there? They must then make the answers to these questions available. Nievergelt suggests displaying short lists of command options on pages. Although this would be difficult with videotex because of space restrictions, options could be provided at key positions such as the last page in a document series. Nevertheless, users should be notified somewhere of the command options available to them.

Williamson (1981) categorizes expectations which users will have as they use a viewdata information retrieval systems:

1. to be able to locate information related to a specific request;
2. to be able to browse through the contents of the system, so as to make a choice from among a number of topics:
3. to have the assurance that most of the information pertinent to the request has been retrieved;
4. to be able to avoid retrieval of information not relevant to the request.(p.4)

This list must be kept in mind as the database is organized. Williamson also recommends the addition of a subject or alphabetical index to the database to circumvent the tree structure if desired.

Shneiderman (1979) presents a collection of design criteria for interactive system designers. These criteria may be applied to the interactive dialogue between a user and a videotex database. The recommendations include; avoid boredom, panic, frustration, confusion and discomfort, minimize memorization, engineer for errors, provide shortcuts for experienced users, be certain the the system responds consistently, all actions should be

user-controlled, dialogue (commands etc.) should be simple, clear and easy to understand, the system should be forgiving with respect to errors, users should be able to escape, help should be offered, and the system should be adaptable to the user's ability. Schneiderman summarizes by advising against the violation of the limits of short term memory, suggests sensitivity to user anxiety and desire to control the dialogue, and emphasizes the importance of designing for errors on the part of the user.

Good database structure can be accomplished through the use of storyboards. They can be pinned on the wall in the database structure, allowing visualization and testing of various search paths. Pages can be checked for instructions and directions at various points in the search path, and adjustments can be made in problem areas. Pages can be reordered, or topics and sub-categories can be altered, deleted or added. Page identification and menu options can be clarified. User errors and questions can be tested at various levels in the structure. This visual analysis of the search logic is invaluable. It has also been suggested that a diagram of the database structure would be very useful to viewers, to help them visualize the structure and organization of information (Sutherland, 1980; Jackson, 1979).

Generally, the database must be carefully and logically organized. The search process should be kept simple in consideration of naive users. Every effort should be made to anticipate errors and confusion, and to clearly identify options for where the user can go, how they can get back to an index, or what they should do next. Instructions and orienting devices on individual pages will be vital to keeping the user from getting lost or confused. The final, vital key to good database search structure is proper index or menu page design.

Index page design
Poor index design can contribute to difficulty in finding one's way around a videotex tree structured database. Several authors have studied the subject of videotex index design and come up with guidelines for creating these pages. In a study done for the Department of Communications in Ottawa (1981), Latremouille et al., found that people make a great number of errors when selecting from index choices, and that many errors occur in the first two levels of the tree search. Based on their experiments, they offer the following advice. Testing tree indexes with naive users and target population is important. Preference and performance should be measured. Care should be taken to avoid miscategorization. Index categories should not be ambiguous or vague. The term miscellaneous should not be used. Equal quantity of information should be contained within each category offered in the index. There should be at least four index choices on the page. Menu items should be rationally ordered either alphabetically or with high use items at the top. Item descriptors can reduce errors. (65% of test subjects preferred the addition of descriptors to menu items.)

Reynolds et al. (1978) recommend that viewdata indexes be kept simple and uncluttered. Single digit choices are considered best. Numerical choices should be positioned to the left of the menu choice; so as to avoid error in reading across a distance, to numbers on the right. Indentation of entries is not recommended.

Whelan (1982) stresses the importance of maintaining a balance in the number of index levels. If there is a large amount of information it may be necessary to have many succesive index levels. However, searching too many index levels will irritate the user, who may give up the search. At the same time, there must be enough flexibility of access from various routes in the database as well as enough menus, to satisfy the users information needs.

Sutherland (1980) also suggests that in videwdata indexes, keying numbers should appear on the left, vertically aligned, and in continuous sequence. If index descriptions occupy more than one line they should be separated by space or, the presence of the keying number may be a sufficient indicator of a new entry. Sutherland also discourages indenting, which disrupts reading flow. Number of recommended choices is five to seven. Users have trouble with the number "0". Its use should be avoided. Menus should

start at "1". Key numbers should be the same colour. Sutherland also recommends the addition of descriptors or examples to menu categories. Menus should be designed to incorporate changes and additions, but blanks should not appear in the index. Page creators should not put demands on the user's memory in the routing pages as users are unlikely to remember information other than that which they are seeking.

Davis and Swezey (1983) also offer recommendations for computer graphics menu selection dialogues. They claim that the main menu should always be available to the user. Menu choices should be well defined. Choices should be limited to five to nine categories, Option lists should be presented in sequence according to probability of access. Equally probable choices should appear alphabetically or numerically ordered. Options which are related should be grouped.

Finally, page creators should make certain that display time be kept to a minimum for index pages, especially if they are referred to frequently. One videotex trial (Elton and Carey, 1983), showed that 40% of all frame accesses were index pages. Complex graphics or unnecessary information will add to the amount of time users must spend on index pages. Index frames should be kept clear and simple. Elements should be arranged on the defined grid in a format consistent with related pages. Instructions as to how to use the index should be provided. Categories, and hierarchical menu search should, if possible, be tested on potential users.

Viewer interaction

It is clear that user interaction with videotex information is an important consideration when creating and organizing pages. McLaren (1983) draws an analogy between videotex and Christopher Evans' "dynamic book". Unlike traditional "passive" printed books, videotex has the capability to search, sift and provide information in a more intelligent manner than the book, and allows innovative interaction on the part of the reader. McLaren emphasizes the potential of this distinguishing characteristic of the medium.

As well as using the videotex system for information retrieval, videotex users, can, with some systems, exchange messages, bank, shop, or play games, all activities involving action on the part of the user and response or reinforcement on the part of the system. On a simpler level, users control *what* they view, and what *pace*, the information is viewed at. They can also alter the contents of a page by requesting further information with a key press, or they can initiate animation or developmental overlays. The system can ask questions, and users can key in an answer, and get a response. Interaction can take place both in the single page and throughout the database.

"Programs which just page through several frames of information without requiring some significant response from the user have little added value over a book. In fact, a book is likely to be more flexible and convenient. In general, the more interactive a program is the more interesting it is." (Merrill, 1982, p.410). The opportunity to actively participate in the delivery of information is clearly more stimulating than passive absorption of that information. Furthermore, programmed instruction theory has shown us that this kind of participation increases viewer attention and retention (Jonassen, 1982).

Page creators are urged to exploit the interactive capabilities of the videotex system. Wherever possible, users should be given the opportunity to play an active role in the presentation and manipulation of information. This will given them a sense of control, will provide some sort of dynamic feedback for their (keypress) requests, and will make the entire activity much more interesting.

Summary

Page creators must identify and control visual messages to be delivered to the user. The planning process should be reviewed. Message transmission must be accurate, precise and effective. All page aspects (text, colour, form and the design principles) should be manipulated to facilitate effective production, transmission and absorption of defined messages.

Viewing hierarchies must be established on four levels; in the static page, in the animated page, in the page display order and throughout a database or page series. Visual emphasis should be used to establish viewing order within a page. Unintended automatic fixation should be avoided. Movement is particularly distracting. Page creators should allow users to initiate any animated activity. Page display order should be carefully controlled. Users should be given text to read while pictures develop. Number of levels in a viewing hierarchy should be kept to a minimum.

Page creations must consider the "invisible dimension" and help the user to connect and navigate information. Single and multiple pages should be designed on storyboards and overviewed for consistency and unity. Page format and colour scheme must be predetermined.

Single pages must be kept simple and uncluttered. Any unnecessary information should be eliminated. Pages should not be filled. They should contain blank space. Information should be chunked. Display time should be kept to a minimum. Illustrations to text should appear on the same page. Each page should contain our compact idea unit. Pages should be neatly organized. Pages should stimulate and interest the viewer. Pages should require minimum effort to view, perceive and interpret.

Related pages must be visually connected, through structure and colour scheme. Consistency of position, language, coding, use of space, system response and instructions is essential. Page creators should design for expectations. Each page must orient and direct. Section and page number plus an instruction as to what to do next, should appear on each page. Complex logos should not be used as identifiers.

Margins should be used. A fifteen pixel border on each side is recommended. A grid must then be defined and consistently used for positioning and organizing page elements. Column width should be determined by text line length. Page creators should vary use of the grid to prevent monotony. Boxes are useful organizers for pictures. Various formats should be pretested on-screen.

Page creators must control database organization, search path, and dialogue between system and user. Page routing logic must match user's idea of what that logic is. Users must be told how to return to indexes. Search path should be kept simple. Hard copy or key word indexes may offer assistance in search. Users should know where and how to proceed at all times. Users should not have to access information they do not want. Page creators must anticipate errors, confusion and questions. Search strategy should be tested with storyboards. A database diagram may be useful to users. Pages must be logically structured. Instructions must be clear.

Index pages should be tested on potential users. Menu choices should be carefully and unambiguously categorized. An equal amount of information should be contained in each category. Menu choices should be ordered logically, either alphabetically or with high use items at top. Category descriptors are useful. Numerical choices should appear at left of the category. Indenting is not recommended. There should not be so many index levels that the user becomes irritated. Only five to nine menu options should appear in one index. The number "0" should be avoided. the main menu should always be available. Index page display time should be very short. Index pages should be clear and simple, and should fit the grid. Instructions for using the index should be provided.

Page creators should exploit the interactive capabilities of videotex. Users should be given an active role in the presentation and manipulation of information.

Medium unique aspects of page synthesis
Many unique characteristics affect page synthesis; space restrictions, landscape format, motion and time, user interaction, database structuring and so on. Most important, single pages can not be created without considering the relationship of one page to other pages in the set or database. It is easier for a user to get lost when viewing videotex pages than when

viewing a book. Because of these unique problems, page format and structuring are inclined to fail in two respects; pages become cluttered too easily, and pages lack any visible or contextual connection to other pages. Order clarity and consistency are even more important in this medium than in other mediums.

Viewing hierarchy must be considered on four levels; in a static page, in an animated page, in the page display order and throughout a database or page series. There are also multiple methods and options for manipulating hierarchical emphasis with videotex; timing, display overlaying, colour brightness, interaction, animation or blinking. Scan paths can be complex and easily confused. The possibility for unwanted automatic fixation is great. It is difficult to control so many methods of emphasis. Controlled interruption of the display hierarchy is possible for clarifying information or temporal occurrences. The system also offers users the ability to control hierarchical display of information by interacting directly with it, through keypresses.

The digital storage and organization of information is unique. Only one unit of information can be viewed at one time. The context within which the page sits, is invisible. Viewers do not know the nature and quantity of other information or if other information does in fact exist. The user may not be able to find existing information.

Within the single page, unnecessary information must be eliminated to avoid clutter. There are many more variables at work in a videotex page than a printed page (animation, display order, instructions etc.). The use of blank space becomes especially important. Page display time and order must be considered. Pages must be designed to incorporate changes or updates. In order to maintain the train of thought, illustrations to text must appear on the same page. Individual pages must be capable of standing alone as an idea unit, as only one or a few unrelated pages may be accessed by a user.

Related pages must be visually connected to assist users in understanding context. Consistent structure, colour and position are essential in order to prevent the user from getting contextually lost. Every page designed must orient and direct. The number of pages in a related set must be limited in order to keep viewer attention. Complex logos can not be used as identifiers to connect pages, as they take too long to display.

Margins must be used to compensate for overscan, screen curvature and fixation distribution. The grid is crucial to this medium; it connects related pages structurally, provides consistent positions for orienting and directing codes, and imparts visual order in an otherwise chaotic display. Page creators can experiment with alternative grid systems, "on screen" prior to defining a format.

Page creators must contend with database organization and search. If it is not logical, users will get lost. Users are basically unfamiliar with computerized information search and must be carefully guided. Page creators must anticipate questions, confusion and problems and work the answers into the search logic. The user's idea of the structure of pages may differ radically from the actual structure. Users must be given a "sense" of the information structure. Users must understand the available commands and options, although they may not be visible. Storyboards are very important to database structure and search logic.

A good index is necessary for efficient information search. Options must be clearly and unambiguously categorized. Categories should contain about the same quantity of pages so users know what to expect. Number of index levels must be controlled so enough detail is provided, but so the user does not become irritated with the search. Numerical choices must be positioned close to the category, preferably in a vertical column on the left. Optimum number of items in an index is only five to nine. The main index has to be readily available. Users will however, only retain a limited number of things in memory, so page creators can not rely on memory for options available to users. There is also no space to repeat options. Index page display time must be considered. Additional indexes (hard copy or

keyword) may be necessary to help orient the user.

Videotex provides the option for viewer interaction. Users can (in some cases) send messages, bank, shop or play games. They can control the pace that information is presented at, initiate animation or developmental overlays, answer questions or select varying search paths. The system is more participatory and dynamic than a book, and users have more of a sense of control over the information.

Summary

Summaries for the guidelines and medium unique factors have been provided at the end of each section in this report. This summary serves only to highlight what the author considers significant recommendations or special findings, discovered in the course of this project.

This investigation has revealed the chaotic state of videotex page design. On the other hand, it has also uncovered the fact there is enormous potential for this medium in terms of dynamic communication, and that the features unique to the system rather than being considered as limitations, can be exploited to advantage. Unfortunately, the project also shows that much is to be learned about human factors aspects of videotex text and graphics presentation. Much research must be undertaken in order to fully realize and utilize the capabilities of this medium. Some important recommendations can however, at this point be emphasized.

Far too little attention is paid to planning for videotex page design. More consideration needs to be given to the user- their nature, their information processing conventions, their problems and their interaction with the system. Page creators need to define and fulfil objectives, and to take a larger overview of the single page and its relation to other pages. Consideration of the planning process reveals that the page creator has a much larger responsibility than just being an input person.

One of the major factors contributing to the failure of videotex page design is the utter disregard for typography. Page creators are consistently oblivious to how important text selection, organization and manipulation, is to the success of an information display. Page creators still follow print habits- and bad print habits at that. Upper case lettering, although most frequently used, is not necessarily best for legibility and readability. The line length most used in videotex pages (full screen width) is unacceptable for the small text size and default leading. Line length should be twenty to thirty characters. Text should always be neatly arranged flush left. Proportional spacing is superior to "gappy" non proportionally spaced text. At this time, light text on a dark background is clearly the most acceptable presentation mode. Flicker is simply too big a problem to ignore. More attention must be paid, on the part of page creators to luminance contrast when presenting text, to insure legibility. Page creators need to be conscious that such a thing as a viewing hierarchy, exists. Blinked, stacked and scrolled text are very hard to read and should be avoided. Better font designs are urgently required. Graphic designers need to be consulted in this respect.

Colour abuse also contributes greatly to the poor quality of videotex page design. Colour choices are garish, too bright and generally invidious. Page creators must control luminance, and end the fascination with bright colour. The manipulation of saturation and luminance, to "tone down" colours is essential. Only three or four colours, in addition to the neutral grays and perhaps a background colour, should be used in any one page. The use of a light, a medium and dark colour is most effective. Light colours (on a dark background) should be used for highlighting as they are most conspicuous.

The use of pictures is extremely important to visual communication. Pictures are clearly processed, stored and recalled more efficiently than language. They should be used in the design of videotex pages. Page creators use form for decoration. This is unacceptable. Form should be functional. In all respects, simple, graphic, stylized pictures make more sense than illustrative drawings. Pictograms are very effective. Solid pictures are less busy than linear drawings. Solid shapes should be used. Fill values are of little use, in view of colour options available, and of the increase in display time and "busyness" they cause. Animation can be very useful, but also very distracting. Repetition of detailed logos must be avoided.

Page creators must become aware of basic design principles, understanding that every element on a page interacts with the rest of the page elements. Knowledge of the design principles can help in the control of viewing hierarchy, emphasis, unity, harmony and

interest value. Movement, time and speed are particularly complex variables requiring more research and experience.

The videotex page is far more complex in its variables (animation, electronic colour options, timing and so on) than a printed page. The page must be stripped to its barest essentials in order to keep it from being cluttered and confusing. Special attention must be paid to elemental display order. Page creators should allow interruption of the display to explain information more clearly. Viewers should have something to read while pictures develop. Furthermore, users should be given control of animation so they are prepared to experience it.

The "invisible dimension" is a curious and confusing phenomenon for users. Page creators are conscious of the nature and quantity of information available, but seem to be oblivious to the user's perception of what information may or may not be forthcoming. Page creators need to concentrate more on orienting and directing users. Again, an overview plan is required. Related pages must be visually connected. The use of a reference grid system is critical to guiding the user. It provides positional codes and consistent structure. Database search really should be pretested. Careful index page design is clearly very important to search success. The potential for viewer interaction with videotex information is largely ignored. Its use can be stimulating and helpful to viewers.

Further research

Almost every issue presented in the course of this investigation requires further research. As the technology improves, even more research will be needed. The following are some topics recommended as urgently requiring investigation and testing with the videotex technology *specifically*. (Many of these issues have been tested in other mediums, but few have been tested on the videotex system.) These topics relate to videotex page design and viewing with NAPLPS videotex technology in its current state only.

- subjective comparison of pages which are planned as related page groups versus those designed as isolated entities
- effect of market specific, versus general videotex information
- effect of pretesting audience specific pages
- viewer computer "phobia" and processing of print versus computer information
- automatically formatted pages versus manually designed pages (subjective and comprehension testing)
- display time threshold
- effect of use of abbreviations in text on reading time
- effect of environmental conditions and display device on reading text
- comparison of print, CRT and videotex, reading rates
- comparison of RGB, RF and composite video presentation of text, reading rates
- effect of "chunking" on reading rate and comprehension
- legibility/readability of large character fonts
- reading upper versus lower case text under varying conditions (alternate line length, viewing distances, character spacing, leading etc.), especially comprehension testing
- word shape recognition when reading
- present day television and CRT viewing distances
- effect of various line lengths on reading rate
- comparison of text arrangements (flush left, flush right, centred, random)
- proportionally spaced text versus nonproportionally spaced text, especially with a shorter line length
- effect of adjusting word spacing on reading rate of text
- effect of flicker on (CRT and TV) reading
- dark text versus light text
- contrast thresholds for text legibility
- colour combinations for text and background
- viewer response to use of red and blue for text when luminance and saturation are manipulated
- text colour emphasis
- using capital letters for emphasis
- using underlining for emphasis
- comparison of the above methods of emphasis
- gray versus coloured text
- suitable number of colour changes for text
- paragraph indenting versus linespacing, when shorter line lengths are utilized
- indent size

- appropriate number of levels in text hierarchies
- using a luminance hierarchy for text
- blinking text
- stacking text
- scrolling text
- research with videotex colour *specifically*
- colour and eyestrain
- high luminance versus low luminance colour
- highly saturated colour versus desaturated colour
- number of colours suitable for a page
- whether the use of grays contribute to display colour "overload"
- colour coding
- number of colour codes
- using light colour for emphasis
- colour conspicuity
- saturation thresholds for small colour areas
- colour associations
- colour area and flicker
- blue and red in combination on the same page
- choosing colour combinations
- text and background colours, varying hue saturation and luminance
- use of rules for structuring information
- symbol/picture recognition by various audience types
- decorative form versus functional form
- simple form versus detailed illustration
- stylized versus realistic pictures
- display time thresholds for graphics
- characteristics of form which is perceptually easy to process
- viewer preferences for picture complexity
- linear versus solid shapes in pictures
- effect of outlining
- use of pictograms
- communicating with graphs
- use of depth and volume
- use of fill values
- all aspects of animation including function versus entertainment value of animation
- effect of allowing viewers to initiate animation
- stylistic limitations of the medium
- multiple page element interaction as compared to single element testing
- how page display time and order can be exploited
- perception and the design principles (most of the design principles are already well established with respect to other mediums and seem to be transferable to this medium)
- how design principles affect scan paths
- movement and conspicuity and automatic fixation
- effectiveness of blinking page parts
- limits on the number of informational elements that can be effectively delivered in one page
- cluttered versus uncluttered pages
- effective message communication methods
- acceptable number of viewing hierarchy levels
- how page buildup affects viewing order
- effect of giving viewers text to read while pictures build, on display time acceptance
- viewer comprehension of the "invisible dimension" and database structure
- filling the page versus leaving blank space
- use of chunking in pages
- viewer reaction to print-like page format versus other formats (acceptance and comprehension)
- effect of running text from one page over to another
- related page series versus multiple unconnected pages
- visually linked pages versus related pages with no visual connection
- importance of orienting and directing devices on every page
- pages with margins versus pages without margins
- overscan allowance for current television technology
- usefulness of a grid system
- minimum distance between columns of running text
- "boxed" pictures versus "unboxed" pictures
- characteristics of effective database structure
- amount of assistance required by database users
- typical user questions, needs, expectations when searching databases
- usefulness of supplemental (hard copy, key word) indexes to information
- effectiveness of pretesting of search logic
- usefulness of a database diagram to users
- characteristics of effective index design
- effectiveness of pretesting index design
- category naming
- optimum number of menu choices
- acceptable number of index levels
- keying number position

- user expectations at the menu level
- frequency of index access
- benefits of user interaction with the system
- interactive pages versus non-interactive pages
- methods of creating interaction

Future topics
The extent of this project has been limited to the very basic fundamentals of visual communication design for videotex. The subject is actually very complex and there is yet, much to cover. Several topics may be identified as subjects for future additions to this investigation, and/or as extension modules to the software:

1. Advertising design
2. Advanced typography and font design
3. Animation
4. Advanced illustration techniques
5. Videotex as a tool for print
6. Chart and graph design
7. The design of tabular material
8. Advanced database structuring
9. Videotex and other mediums (video, sound, laser disc etc.)
10. A videotex glossary

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List of slides

The following slides are a representative sampling of the original approximately 250 pages from the software instruction programme prepared for this project. They have all been shot directly from the CRT screen.